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CORRELATION OF GASTROSCOPIC AND PATHOLOGICAL FINDINGS IN GASTRITIS

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ACCURATE data correlating what is seen by the gastroscopist in the living stomach with what is seen by the pathologist in the dead stomach are hard to obtain and often difficult to evaluate. An area may be described gastroscopically as reddened, hemorrhagic, eroded, verrucous, etc., and at least nine times out of ten no pathological check is possible for usually patients with gastritis alone do not come to autopsy and do not require operation. If, by chance, such a patient does come to autopsy the objection may be raised that autodigestion has rendered almost valueless any gross or histological study of the gastric mucosa. In surgically resected specimens operative trauma from handling or clamping the stomach has been said by Schindler, Necheles, and Gold to invalidate the findings. Faber's monograph on gastritis is a real contribution to our knowledge of the subject but the work is purely from the pathological standpoint as no gastroscopic observations were made. Swalm and Morrison examined 25 cases with the flexible gastroscope shortly after which biopsies were obtained by Dr. Chevalier L. Jackson and his associates, through the open tube gastroscope. These writers conclude that histological diagnosis agrees with gastroscopic diagnosis in normal or gastritis stomachs in 52 per cent of cases and that the gastroscopic appearance of a severe gastritis is usually verified by the histological examination but the gastroscopic appearance of a mild or moderate degree of gastritis or normal stomach may be contradicted upon histological examination. While this series of cases was apparently studied with care and without prejudice, the number of cases examined was small and the histological verification of gastroscopic observations disappointing.

This report is based on a careful analysis of 51 selected cases in which satisfactory gastroscopic study was followed by histological examination. Eighty-four cases were discarded as unsatisfactory because of incomplete gastroscopic notes, poor microscopic sections, small biopsy specimens only, or too long a time interval between gastroscopy and operation. Six biopsy cases were discarded because we felt it was not fair to either the gastroscopist or the pathologist to expect the latter to make a diagnosis as to the entire gastric mucosa from a small and sometimes mutilated biopsy specimen. In this series of 51 cases there were 23 ulcers (18 gastric, 3 duodenal, 2 jejunal), 22 carcinomas, 2 cases of

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gastritis alone, 2 lymphomas, 1 benign polyp, and 1 normal stomach. Specimens were obtained in all cases by surgical resection.

A control series of 50 stomachs removed at autopsy as shortly as possible post mortem (2 to 3 hours on the average) and fixed with particular care was utilized for purposes of comparison. The detailed histological studies of the two series will be presented elsewhere. They were carried out with two purposes in mind. First, it seemed important to check upon the possibility, raised by the reports of Schindler, Necheles, and Gold, that important inflammatory changes may develop in the course of surgical resection due to the continued action of gastric juice upon a mucosa deprived of its blood supply by the surgeon's clamps. We found few mucosal defects such as these authors illustrate in our material, provided (1) the resection was performed by a competent surgeon, (2) the specimen was promptly delivered to the pathologist without palpation by numerous intervening hands, and (3) the organ was fixed immediately after it was opened, to prevent drying of the surface. When found, such lesions were dismissed as artefacts. The slight plasma cell infiltration illustrated by these authors as evidence of inflammatory reaction about the mucosal defects is unconvincing. Considerable local variation in the almost invariable plasma cell infiltration of the gastric mucosa is the rule and of all possible types of wandering cell infiltration which might be attracted to such an acute lesion, the plasma cell, the prototype of chronic inflammatory processes, is the least likely to make such an immediate response.

We found only two fairly constant variations between the resected specimens and comparable cases from the autopsy group other than the more perfect fixation of the former. The tips of the villi were more frequently edematous in the resected group and the loose layer of fibrous tissue between the muscularis mucosae and the main muscular layer was regularly wider. Capillary engorgement, degrees of neutrophilic leucocyte infiltration, frequency of erosions and of interstitial hemorrhages were not disproportionate in similar cases from either group. Consequently we believe that resected specimens, despite a slight tendency to edematous swelling, are entirely suitable for comparative study of histological and gastroscopic findings, the primary purpose of this report.

The second necessity for a control group was to study the chronic inflammatory infiltrate of plasma cells, lymphocytes, and usually eosinophiles which virtually every stomach shows in varying degree. For purposes of rough quantitation four grades were distinguished. Grade I was defined as scattered small foci of plasma cells, grade II as a narrow, continuous band localized sharply about the neck zone of the glands. In grade III the band has become wider and may occupy one-third to one-half of the total width of the mucosa. Grade IV extends from this to complete infiltration of the mucosa from villus tip to muscularis mucosae. It should be pointed out that this division is entirely artificial and simply for purposes of convenience, since every grade of transition from the least to the maximal can be observed. It is, furthermore, important to emphasize that the differences are purely quantitative not qualitative, and maximal infiltration of grade IV represents merely an exaggeration of a process to be found in virtually every stomach.

The results of quantitative estimation of the degree of infiltration of the nonacid producing and the acid producing (labelled respectively for the sake of briefness antrum and fundus) mucosae of the control series and the resected specimens appear in Table I. The figures indicate the percentage of specimens examined showing the various grades of infiltration.

TABLE I.—CHRONIC INFILTRATION

	Grade	I	II	III	IV
Autopsy series					
Antrum	0	14	46	38	2
Fundus	8	26	50	10	6
Resected specimens					
Antrum	0	0	13	26	61
Fundus	0	10	41	29	20

From inspection of these figures it is evident that no stomach was found without some infiltration of at least the antral portion (including 1 infant 36 hours after birth) and that grades I and II (Figs. 1, 2) of infiltration are so frequent

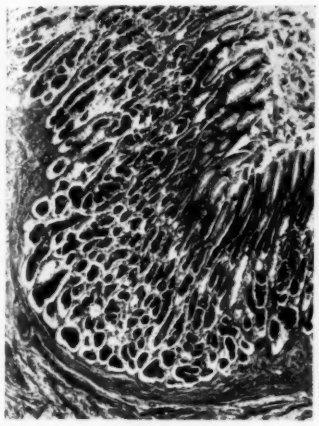

Fig. 1.

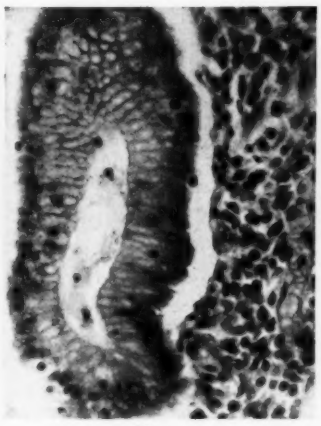

Fig. 2.

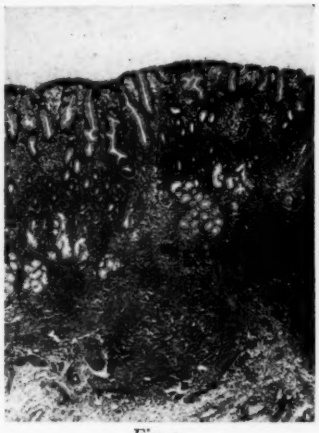

Fig. 3.

Fig. 1. Photomicrograph showing Grade II, chronic infiltration of the fundus, limited to the neck zone; within normal limits. ×30.

Fig. 2. Neck zone from antral region showing plasma cell infiltration and physiological exudate of leucocytes into the gland. ×170.

Fig. 3. Grade IV, antrum. Pathological exaggeration of chronic infiltrate occupying two-thirds of mucosa. ×30.

that they must be considered to be within normal limits. Grade IV (Fig. 3), which was rarely found in the control series but was common in the diseased stomachs of the resection group, is obviously pathological. Grade III (Fig. 4) is on the border line. Infiltration of this intensity in the fundus is probably abnormal and was so classified in this study. In the antrum, where the degree of infiltration tends to run one grade higher than in the fundus we chose to consider grade III within normal limits and only grade IV as definitely pathological. In the comparisons with the gastroscopic findings to be detailed below it has been assumed that chronic infiltrates of grade IV intensity in the nonacid producing

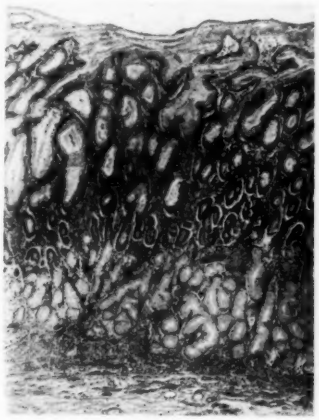

Fig. 4.

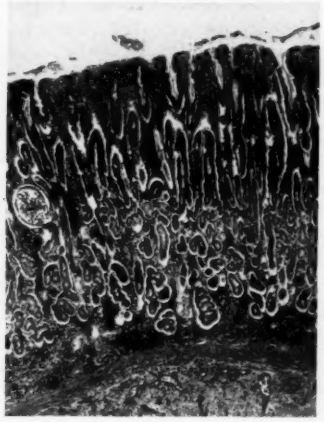

Fig. 5.

Fig. 6.

Fig. 4. Grade III, antrum. Upper border of normal limits of infiltration. Classed as normal. ×30.

Fig. 5. Acute or superficial gastritis. Mucin vacuolization gone and leucocytes fill upper third of mucosa. ×30.

Fig. 6. Higher power of portion of Fig. 5. The epithelial cells have lost all functional differentiation and large numbers of leucocytes are present beneath and between them. ×170.

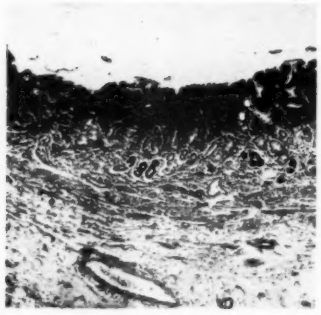

Fig. 7.

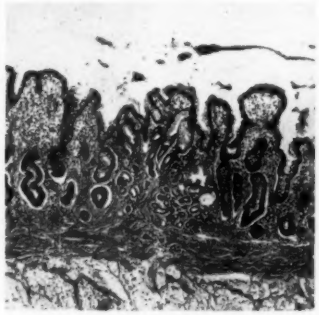

Fig. 8.

Fig. 7. Early atrophy of the fundus. Shortening of the glands with partial lack of differentiation. ×30.

Fig. 8. Atrophy of antrum. Few recognizable gastric elements remain. Intestinal metaplasia is almost complete. ×30.

mucosa and of grades III and IV in the acid producing mucosa are the histological counterparts of so called "hypertrophic gastritis." If, as we believe we have demonstrated, this is the case, "hypertrophic gastritis" represents an exaggeration of the "physiologic gastritis" of normal stomachs.

A second type of gastritis, to be correlated below with the "superficial gastritis" of the gastroscopist, presents significantly different histological findings. In the chronic type which has been described the differentiation and apparent functional integrity of the epithelial elements of the mucosa is remarkably well maintained in even the most severe grades. In this second type the mucin vacuoles which normally almost fill every cell above the neck zone of the glands including all the surface cells covering the apices of the villi become smaller and smaller until in the severe grades they disappear entirely (Fig. 5). Along with this gradual diminution in the mucous vacuolization, polymorphonuclears appear in large numbers in the interstitial tissues of the upper portions of the mucosa. Frequently they can be found in large numbers just beneath the surface epithelium and wandering between these cells into the lumen of the stomach (Fig. 6). In severe cases the failure of differentiation of the epithelial cells may extend downward from the neck zone toward the bases of the glands and in such instances leucocytes will be found as deep as the muscularis mucosae. "Superficial gastritis," then, is superficial in the sense that the surface is always involved but not in the sense that only the upper portion of the mucosa is abnormal. It is an acute exudative process and as such can be superimposed on either of the other two types.

A word of caution must be inserted regarding the significance of neutrophilic leucocytes in the mucosa. Hamperl has clearly shown that neutrophiles may frequently be found in normal stomachs but he also clearly pointed out that they, like the early stages of plasma cell infiltration, are sharply limited to the neck zone. The leucocytes must stray widely from this area and be associated with some deficiency of mucous vacuolization before the diagnosis of acute exudative, or in gastroscopic terms, superficial gastritis is justified.

The third clearly characterized type of gastritis is the atrophic. In the atrophic mucosa the significant feature is the progressive diminution of the epithelial elements, particularly the differentiated elements at the bases of the glands (Fig. 7). The glands become shorter; they lose their terminal convolutions; a gap appears between the base of the glands and the muscularis mucosae. Gradually they become more widely spread and the intervening interstitial tissues show proportionate increase. Usually the muscularis mucosae is infiltrated with fibrous tissue and the layer of underlying loose areolar tissue often becomes narrowed and fibrous. This process may be accompanied by

Fig. 9. Hypertrophic gastritis with erosions.

Fig. 10. Superficial gastritis.

Fig. 11. Atrophic gastritis.

any grade of acute or chronic inflammatory infiltration. Metaplasia of the intestinal type appears in more and more numerous foci and eventually may entirely replace all proper gastric elements (Fig. 8).

By gastroscopy we describe three types of gastritis: hypertrophic, superficial, and atrophic. Not infrequently in the same stomach there will occur a mixture of two types, superficial and atrophic or superficial and hypertrophic. In one instance gastroscopy showed marked hypertrophic gastritis, moderate superficial gastritis and one area of localized atrophy. This case was corroborated by the pathologist in all respects.

By hypertrophic gastritis (Fig. 9) the gastroscopist means a mucosa studded with verrucous elevations having a dull surface with few highlights and sometimes a beaded appearance to the rugae. The pathologist does not see verrucous elevations in the mucosa to which he can certainly attribute pathological significance. This, however, does not disprove their existence in the living stomach nor does it prove their insignificance in gastroscopic diagnosis. The counterpart of the hypertrophic gastritis described by the gastroscopist appears to be the chronic gastritis which the pathologist recognizes by an exaggeration of the zone of plasma cell infiltration which in some degree is found in almost every stomach.

By superficial gastritis (Fig. 10) the gastroscopist means increased reddening, edema, and adherent secretion. This type we have found to correspond with the acute exudative gastritis described by the pathologist. Superficial gastritis may, therefore, be regarded as an acute process and may be superimposed on the atrophic or hypertrophic varieties.

The gastroscopist and pathologist agree in defining atrophic gastritis (Fig. 11) as atrophy of large areas of the mucous membrane, seen gastroscopically as a pale, thin mucosa with a network of easily visible blood vessels. Whether or not atrophic gastritis is the end-stage of an inflammatory process and, therefore, a true gastritis, or the result of a vitamin or other deficiency and, therefore, better termed a gastric atrophy, is an unsettled problem beyond the scope of this paper. There is some evidence that both an inflammatory process and a deficiency factor may play a part.

In comparing the gastroscopic and pathological findings in all types of gastritis in this series one finds complete correlation in 28 of 51 cases (54.9 per cent), partial correlation in 17 (33.3 per cent), no correlation in 6 (11.8 per cent). There was, therefore, complete or partial correlation in 45 cases (88.2 per cent). By partial correlation we mean that the pathologist has confirmed one part of the gastroscopist's observations but has not confirmed another part or has added an observation not mentioned by the gastroscopist. For example, in one case (U#-44513) the gastroscopist noted multiple benign gastric ulcers with erosions and superficial gastritis. The pathologist noted extensive and severe gastritis with focal atrophy of significant dimensions

but minimal intestinal metaplasia. Since no atrophy was noted by the gastroscopist this case is classified as only partial correlation. The 6 cases of complete disagreement were as follows:

R. H., U#-323184, male, aged 72 years. Resection for gastric ulcer. The gastroscopist reported definite atrophy of the anterior wall. The pathologist found severe antral and moderate fundic gastritis but no atrophy. The disagreement here is complete and cannot be satisfactorily explained. Possibly the supposed atrophy seen at gastroscopy was due to overinflation of the stomach with air, although this is a mistake which should rarely occur; or perhaps the pathologist had no section from the localized atrophic area of the anterior wall. No gastroscopic note was made as to the condition of the mucosa near the ulcer which was partly obscured by mucus and débris.

G. W. F., U#-32095, male, aged 47 years. Resection for prepyloric ulcer. The gastroscopist described reddening and edema of the antrum proximal to the ulcer. The pathologist reported infiltration of the antrum but no more than was found in a series of control stomachs.

M. J., U#-343484, female, aged 66 years. Gastric resection for gastric ulcer. Gastroscopy showed normal appearing mucosa. Histological examination of specimen resected 11 days later was reported as showing extremely severe, acute, diffuse antral and fundic gastritis. This case represents complete failure of the gastroscopist due either to insufficient attention to the mucosa (the main problem being the ulcer) or to failure of the gastroscopic method to detect gastritis in this case. Since the pathologist reported an extremely acute process, it is possible although unlikely that some of the acute gastritis developed in the 11 day interval between gastroscopy and operation

J. S., U#-283404, male, aged 40 years. Resection for pyloric ulcer. Gastroscopy revealed no evidence of gastritis. The resected specimen 3 weeks later, however, showed very severe atrophic gastritis. This discrepancy is probably due either to poor observation by the gastroscopist or failure of the gastroscopic method. We believe the 3 weeks' time interval is much too short for the development of a severe atrophy.

E. McP., U#-198331, male, aged 61 years. Resection for carcinoma. Gastroscopy showed marked superficial gastritis. The resected specimen 6 days later showed no more than the usual infiltration seen in the control group.

E. S., U#-286799, male, aged 70 years. Resection for carcinoma. Gastroscopy showed slight superficial gastritis but examination of the resected specimen revealed moderate atrophy. It is hardly likely that a slight superficial gastritis would mask a moderate atrophy. Therefore, this case is recorded as a complete failure in correlation.

Summarizing these 6 cases of complete disagreement we find the following possible explanations: (1) localized area of stomach described by the gastroscopist not sectioned by the pathologist, (2) mucus and débris obscuring gastroscopist's view and warping his judgment, (3) changes in the mucosa due to time interval (even a few days will alter the acute picture), (4) poor gastroscopic view of the antrum in some cases, bearing in mind that the pathologist often finds the most marked gastritis in the antrum, (5) overinflation of the stomach with air simulating atrophy. We do not feel that lack of correlation in 6 cases is any cause for concern. In fact, we believe that the complete and partial correlation in 45 of 51 cases is excellent corroboration of the gastroscopic method of diagnosis in gastritis.

Analysis of each of the three gastritis groups separately reveals further interesting data. Sixteen cases showed hypertrophic gastritis by both methods and 22 cases showed no hypertrophic gastritis by either method, or a total of 38 cases with complete agreement (74.5 per cent). In the 13 remaining cases (25.5 per cent) gastroscopy showed hypertrophic gastritis not corroborated by histology in 4 and histological examination disclosed a chronic gastritis which had not been observed by gastroscopy in 9. Here again the explanation for this discrepancy seems to lie at least partly in the fact that in 6 of the latter 9 cases the gastritis described by the pathologist was confined to the antrum, a percentage error of 12. The time interval should be of comparatively little significance in this group but a superimposed acute superficial gastritis might mask for the gastroscopist an underlying chronic hypertrophic gastritis.

Twenty-five cases showed superficial gastritis both gastroscopically and histologically, and 9 cases showed no superficial gastritis by either examination. In other words, there was complete agreement as to the presence or absence of superficial gastritis in 34 cases (66.7 per cent). There was lack of correlation on this point in 17 cases (33.3 per cent), in 8 of which gastroscopy showed superficial gastritis not confirmed by histology and in 9 of which histological examination disclosed some acute

gastritis which had not been observed by gastroscopic examination. Since, as aforesaid, superficial gastritis as described by the gastroscopist is probably an acute process corresponding to acute exudative gastritis as seen by the pathologist, the time interval between gastroscopy and operation would be of great importance and even a few days' delay might account for great discrepancy. Another factor of significance is the fact that the pathologist frequently finds the process localized to the antrum, an area sometimes relatively poorly seen by the gastroscopist. In this group the error possibly attributable to this source would be 8 per cent.

The cases showing atrophic gastritis were also analyzed separately. In this group 4 cases showed atrophy by both methods of examination and 30 cases showed no atrophy by either method, or a total of 34 cases with complete correlation (66.7 per cent). In the remaining 17 cases (33.3 per cent) gastroscopy showed atrophy not confirmed by histology in 1 and histological examination disclosed atrophy not observed by gastroscopic examination in 16. The explanation for this discrepancy would again appear to lie partly in the fact that in 11 of these cases the atrophy was confined to the antrum, the area which as has already been noted is sometimes poorly visualized by gastroscopy. In this group the error possibly ascribable to this cause would be 22 per cent. In some cases the atrophy may have been masked gastroscopically by a superimposed superficial gastritis.

CONCLUSIONS

This report is based on a comparative gastroscopic and histological study of 51 cases selected from a total of 135 on the basis of completeness of gastroscopic notes and adequacy of histological material. All were surgically resected specimens.

We believe that surgically resected stomachs are satisfactory for the pathological study of gastritis and that the element of trauma incident to surgical procedure can be readily distinguished histologically from real gastritis.

We believe that biopsy specimens are inadequate for satisfactory gastroscopic-pathological correlation not only because they afford such a limited section of gastric mucosa for histological study but also because they are more likely to be badly traumatized than are surgically resected specimens.

Superficial gastritis as described by the gastroscopist corresponds to the acute exudative gastritis of the pathologist. The term atrophic gastritis is used by both gastroscopist and pathologist to denote the same type of mucosa. Hypertrophic gastritis as described gastroscopically corresponds to an exaggerated form of the physiological plasma cell and lymphocytic infiltration of the normal stomach.

In the 51 cases in this series including all types of gastritis there was complete gastroscopic-pathological agreement in 28 cases (54.9 per cent) and partial agreement in 17 cases (33.3 per cent) or a total complete or partial agreement of 88.2 per cent. There appeared to be no correlation in the 6 remaining cases (11.8 per cent).

Analysis of the separate types of gastritis showed agreement in 74.5 per cent of the hypertrophic, 66.7 per cent of the superficial and 66.7 per cent of the atrophic.

We believe that the agreement in this series has been very good and conclude that such close pathological verification of the gastroscopic findings in gastritis is an important indication of the value of gastroscopy.

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A METHOD OF COLECTOMY FOR DESPERATE CASES OF ULCERATIVE COLITIS

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PATIENTS suffering from severe ulcerative colitis not infrequently appeal for surgical aid after they have exhausted all medical treatment and when, therefore, they are in a late stage of the disease and suffering from profound anemia the result of repeated bleedings and from great emaciation and debility caused by toxic absorption from the extensive ulceration. No half measures, such as appendicostomy, cecostomy, or even enterostomy, are of any permanent avail in these patients. Nothing short of colectomy will save such a patient's life. But in circumstances such as these, a colectomy, as usually performed, would assuredly fail because the patient's general condition would not permit such a big operation and even if it did the tissues of the intestinal wall would be so deficient in vitality that no union would take place in any intestinal anastomoses. How a colectomy (practically total), in a patient almost moribund as a result of ulcerative colitis, can be carried out by the exercise of patience and by the contrivance of a "sliding scale" type of operation, is illustrated in the interesting record of the following case.

A female patient, aged 40 years (M.L.), had been ill for a period of 6 months, during which she suffered from a progressive deterioration of her general health, a severe secondary anemia which did not respond to treatment, and prolonged attacks of severe diarrhea.

A 5 day attack of acute diarrhea associated with some ill localized abdominal pain and tenderness led to an emergency operation in the belief that she was suffering from an attack of acute appendicitis. A greatly enlarged and inflammatorily infiltrated appendix was found. No misgiving was felt that it was not a case of acute appendicitis.

Three days after the operation, the patient began to have frequent loose motions; to pass large quantities of bright blood with the motions; and to suffer from severe general abdominal pains the incidence of which seemed to be greater on the left side of the abdomen.

After a month she was so emaciated, anemic, and ill that she was only kept alive by repeated transfusions of blood. Her hemoglobin value was 40. The region of the large bowel was diffusely tender.

A barium clysma disclosed a small rectum and a rigid tube-like colon with no haustral markings (Fig. 3).

SURGICAL MANAGEMENT

Step 1: Gas and oxygen anesthesia was used. A midline subumbilical incision was made. The colon from the cecum to the lower part of the sigmoid was found to be uniformly white, opaque, thick, and rigid; it presented all the appearances of an advanced stage of ulcerative colitis. The ileum was normal.

The ileum was severed at a point 4 inches from the ileocecal junction. The distal cut end was implanted in a stab wound in the right iliac fossa. The proximal cut end was implanted in the lower end of the subumbilical incision and the adjacent segment of ileum, was given a wide application, by two rows of sutures, to the lowest part of the sigmoid and the rectosigmoid junction, after the rectum had been drawn tensely out of the pelvis (if the rectosigmoid reflexion of peritoneum is incised the rectum can be drawn well out of the pelvis) (Fig. 1). The sigmoid was cut across at a level that would enable its lower cut end to be implanted side by side with that of the ileum in the lower angle of the midline wound.

The upper cut end of the sigmoid was also implanted in the subumbilical incision.

The disposition of the patient's intestine now was: she had a left sided enterostomy (rational surgical treatment for ulcerative colitis); the terminal ileum was so applied to the lowest part of the sigmoid and rectosigmoid junction that a rectoileal spur was constituted, the crushing of which would make a rectoileal connection; the proximal cut end of the ileum and the distal cut end of the sigmoid lay side by side in the lower end of the

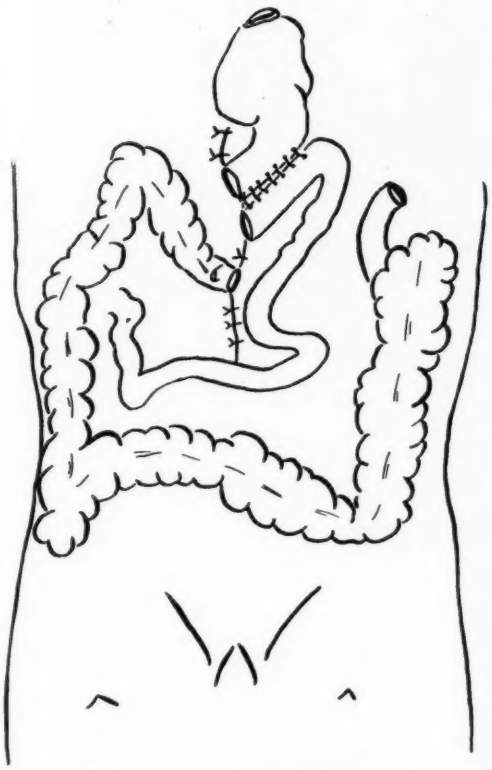

Fig. 1. Formation of the ileorectal spur.

central wound; and the colon, except for a small segment at its lower end was completely excluded with an ileal opening in the right iliac fossa and a lower sigmoid opening in the left iliac fossa.

The excluded colon was emptied of feces and washed out daily with an emulsion of cod liver oil containing sulfanilamide.

In a month the condition of the patient was: general condition greatly improved; considerable pain and tenderness over the colonic region; pus and blood teeming with enterococci (containing no bacilli) pouring from the sigmoid end of the excluded colon.

Step 2: In order to lessen the unpleasant effects of a fully functioning enterostomy on the abdominal wall and to begin the connection of the ileum to the rectum, the ileorectosigmoid septum was crushed with an Oschner-

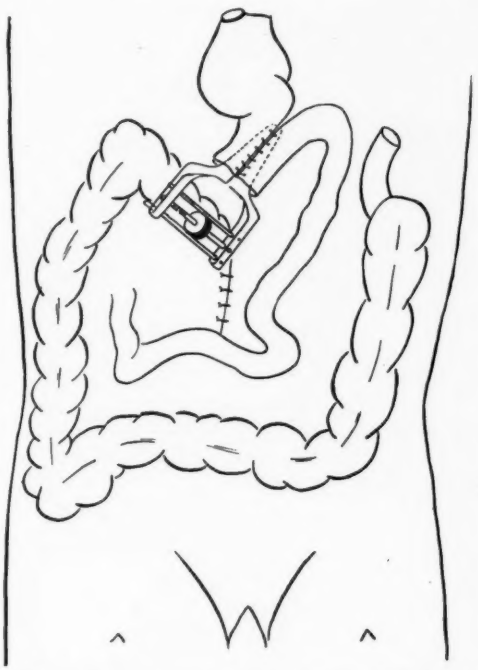

Fig. 2. Showing ileorectosigmoid septum crushed with an Ochsner-DeBakey spur crusher.

DeBakey spur crusher (Fig. 2). The "by-pass" now established into the rectum (in this case not very badly affected) permitted the passage of a quantity of intestinal contents into it, lessened the number of dressings, and soon mitigated the excoriation of the abdominal wall.

Step 3: Two months later the patient's condition had so wonderfully improved that it was felt that the resistance of her tissues was good enough to close the bowel openings. Accordingly, under local anesthesia, the cut end of the ileum and that of the lower end of the sigmoid were closed in layers and the abdominal muscles were loosely sutured over them. To lessen any strain on the sutures in the bowel ends, a rubber tube was kept in the rectum for 2 weeks after the closure (the liquid contents of the small intestine passed very readily through this tube).

Further treatment of the excluded colon with sulfanilamide applications was prac-

Fig. 3. Clysma x-ray showing small rectum and rigid tube-like colon.

ticed and the patient improved rapidly. She still, however, complained bitterly of pain very definitely localized to the region of the excluded colon.

Step 4: Some months later when she appeared to be well enough to stand a colectomy, this final step in the surgical treatment was carried out under nitrous oxide gas and oxygen anesthesia. The operation caused the patient little disturbance. The length of colon removed was 2 feet 9 inches.

When the lumen of the colon was displayed, the mucous membrane was seen to be uniformly involved from the ileocecal valve to the cut end of the sigmoid. It was of a ripe mulberry color, greatly thickened, and was pitted with pinpoint ulcerations. The muscle and peritoneal layer showed extensive chronic inflammatory filtration. In this patient there still remains a small fraction of the sigmoid (about 2 inches). The rectum was not badly involved.

Figure 4 shows the appearance of the mucous membrane.

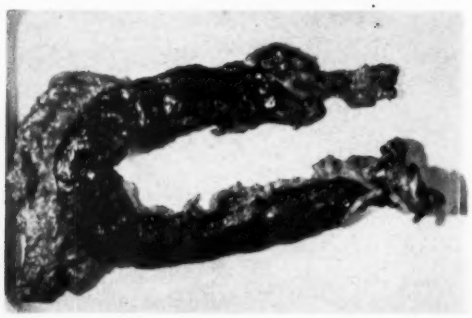

Fig. 4. Resected colon showing the small bit of normal ileum and the colon uniformly affected. The mucous membrane was uniformly thickened, of a deep purple color, and granular with pinpoint ulcerations uniformly distributed.

SUMMARY AND CONCLUSIONS

The surgical lessons arising out of this case are:

1. An unrecognized ulcerative colitis in its early stages may be the cause of severe and progressive ill health.

2. A patient with ulcerative colitis may come to operation in the guise of a case of acute appendicitis because the appendix is, by virtue of its continuity with the cecum and colon, the subject of an acute or subacute inflammatory process.

3. A "sliding scale" almost complete colectomy—in these cases the only operation of any value—can be carried out by a step by step surgical, combined with medical, treatment, allowing ample time between each step to enlist the patient's natural recuperative powers, and designing the whole treatment so that a colectomy is the culminating aim.

In the case which has been presented 2 feet 9 inches of acutely inflamed diseased colon was removed, and the relief and improvement was dramatic.

The patient is now, after 9 months, practically well. The rectum and the small amount of sigmoid left seem to give her a little pain.

This is an example of how an almost complete colectomy can be performed in circumstances which can scarcely be worse.

POSTMETASTATIC SURVIVAL OF OSTEOGENIC SARCOMA

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THIS report discusses the patient from the standpoint of postmetastatic survival from osteogenic sarcoma in whom demonstrable *metastases to the lungs* alone are concerned. My own experience and that of others lead me to believe that once metastases from osteogenic sarcoma have appeared, usually in the lung where they are expected first, or in any other part of the body, the patient is in a hopeless condition. Parents and relatives are usually so informed. Sometimes amputation or local resection is refused after metastases are diagnosed because most patients die within a few months up to a year. In the Registry of Bone Sarcoma of the American College of Surgeons, there seems to be no clear cut instances of osteogenic sarcoma which have developed metastases in the lungs and in which patients have survived for a great length of time.

My patient has been kept under observation 13 years. The outstanding points I wish to bring out in the review are:

1. A definite diagnosis of osteoblastic osteogenic sarcoma of the femur was made primarily by both roentgenological and histological examination.

2. The leg was amputated well above the growth on the femur before any metastases in the lungs could be certified. The tumor was then clinically at least 9 months old and there had been one attack of cough with colored sputum, not examined.

3. Amputation was performed after both femoral artery and vein were doubly tied through a separate incision; no constrictor was employed and the leg was very gently handled during operation.

4. Within 10 months there was chest pain, bloody sputum, and roentgenological evidence and diagnosis of pulmonary metastases.

5. There never developed any local or regional recurrence.

6. The shadows of the pulmonary metastases for a few months seemed to multiply and increase in size, then reached a stationary stage which lasted for several years, finally changed slightly in density but not in size. The change in density might have been the result of improved roentgenological technique or better films.

7. The roentgenological shadows of pulmonary metastases remain after 12 years.

8. The patient is alive and as well as ever. He has maintained a more or less stationary weight for 10 years.

9. There never has been any roentgenological, serum, or other type of therapy, except for one dose of suberythemal x-ray which was given in 1930.

10. The serum phosphatase has never been more than 1.4 units per 100 cubic centimeters since this method of examination has been used.

11. His blood findings show only a secondary anemia.

12. A careful restudy of the primary tumor confirms the diagnosis of osteoblastic osteogenic sarcoma. It is classed as a malignant tumor; it contains some areas with osteoid tissue, cartilage, and many mitotic figures.

13. Although there have been intermittent attacks of cough with blood tinged sputum and many negative examinations for tubercle bacilli over the period of 12 years, no careful sputum examination attempting to find tumor cells in masses has been possible. No exploration of the lung has been performed to obtain tissue for biopsy, either by bronchoscopic examination, puncture, or direct thoracotomy.

CASE REPORT

J. D., male, single, aged 21 years, born in Poland, where he lived the first 8 years of his life, was admitted to the Presbyterian Hospital, on May 7, 1929, with a complaint of painful swelling, which had existed for 9 months around and above the right

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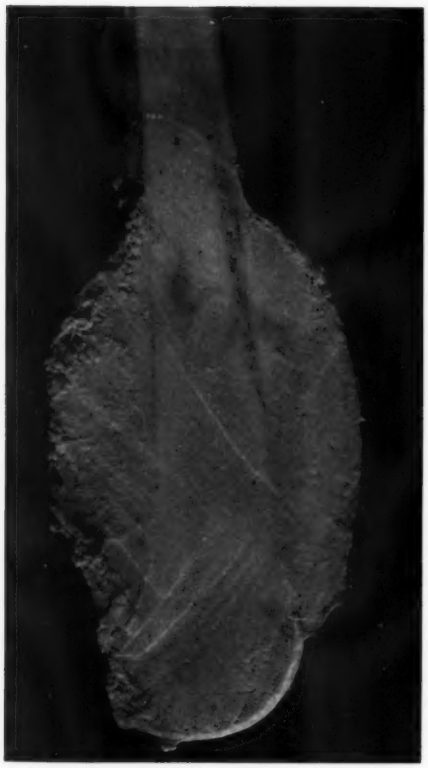

Fig. 1. Longitudinal section through the femur showing the tumor growth with its radiating characteristics and retained identity of the cortical margin in most part. The tumor mass fills the medullary cavity of the portion of the bone shown. Joint surface of the femur apparently is still unaffected.

knee. In that time he had lost 30 pounds in weight. The pain was continuous, increased by standing and by lying in bed, leading to insomnia, but was not completely disabling in walking. He had also in the last 3 weeks before admission experienced severe sharp pain in the right ilium and back, with stabbing pain on deep inspiration. There was some cough considered to be the result of excessive cigarette smoking accompanied by "dusty" and "colored" sputum.

The physical examination showed a slender white male with normal findings except as follows: the abdomen was symmetrically rigid, a condition said by him to have been constantly present. The liver seemed slightly enlarged to percussion but could not be palpated below the costal margin. No palpable lymph nodes were found. Wassermann reaction was negative.

The right knee region was approximately twice the size of the left, presenting a hard, irregular, and somewhat tender swelling which seemed a part of the lower end of the femur. This leg could be flexed to a right angle but could not be fully extended so that he walked with a limp from the contraction, standing fairly well with leg flexed at the knee. When the leg was forced passively beyond the range of voluntary motion, pain was set up.

The urine was normal, the blood showed 80 per cent hemoglobin and 9,200 white blood cells. A roentgenogram May 8, 1929, of the lower half of the right femur and knee showed considerable soft parts swelling with much new bone formation about the lower end of the femur extending outward in all directions from the shaft, in a radial or ray-like arrangement. Shaft (old cortex) of femur was slightly increased in density and the findings were considered to be those typical of osteoblastic osteogenic sarcoma. Two days later, after the arteries of the amputated leg had been injected, a second roentgenogram showed a negative leg and foot and a clear outline of the tumor of the femur found in the primary roentgenogram, its density increased apparently from the injection of the blood vessels by the opaque material used.

A chest film May 9, 1929, was considered to be negative although a solitary dense nodular shadow was present in the left hilum, suggesting a calcified gland or nodule in that position, possibly a small metastasis. Amputation was advised, with the belief that no surely demonstrated metastases had yet occurred.

On May 10, 1929, an incision was made over Scarpa's triangle exposing the femoral vessels which were both doubly ligated and the small opening was sutured. A circular amputation of the upper third of the right thigh was then performed. The sciatic nerve was injected with absolute alcohol, and a narrow rubber tube drain was left across the stump. A normal healing occurred, and the patient left the hospital June 3, 1929.

The description of the amputated right leg on May 10, 1929 (Path. No. 20576, Case No. 236289) follows:

Gross. The specimen is the right leg of a young male, removed through upper third of the thigh. The lower extremity is normal below the knee. A swelling is present from the knee joint up to and including the lower third of the femur. This tumor is fusiform, slightly discolored, and firm. The thigh's greatest circumference is 46 centimeters and the anterior length of the swelling of the tumor is 15 centimeters.

An incision on the anterior surface of the thigh through skin, subcutaneous tissue, muscle, and fasciae reveals a grayish-white nodular mass which anteriorly does not invade the muscles or fascia but has done so posteriorly. The muscle and overlying tissues move freely over the tumor mass. The knee joint is filled with dark fluid blood. The main nodular tumor mass has an irregular, dull gray surface with various sized raised yellow masses studding it, most numerous on the popliteal surface. The greatest circumference of the tumor is 29 centimeters and

the anterior length 13 centimeters, the whole covered by a transluscent closely adhering capsule-like covering.

A longitudinal section through the middle of the femur and tumor reveals on the cut surface a medullary cavity filled with hard, compact bone extending about 21 centimeters in length. There is a small cyst with irregular wall and border near the anterior extremity of this sclerosed cavity filled with dark, soft blood. The cut surface is not uniform in color but is principally white, irregularly splotched with faint brownish red areas, and is bonily rough. The outlines of the compacta of the femur are distinct and unobliterated. That portion of the tumor external to the outer cortical surface of the femur is softer than the portion within the medullary cavity and extends 3 centimeters beyond the edge of the cortex of the femur. This surface is dull and rough. The normal portion of the medullary cavity of the femur is filled with soft, dull, whitish red irregular marrow. The articular surfaces of the femur, tibia, and patella are normally smooth.

Microscopic sections through the tumor show a marked proliferation of mesenchymal tissue cells, the nuclei of which are oval and stain light purple. The cytoplasm is faintly pink and contains numerous processes which extend outward in the form of fibrils. Some nuclei show definite mitotic figures. There are scattered areas of pink-staining new bone.

On March 6, 1930, 10 months after amputation, an examination showed a well healed thigh stump (he wore artificial limb), pain in the chest with coughing and expectorations of bloody frothy sputum. A chest roentgenogram this date showed numerous rounded, dense shadows and a second film on July 29, 1930, showed an increase in the number and size of these shadows. There was also present a uniform clouding of the left upper lobe of the lung which was interpreted to be a pressure atelectasis.

Subsequent roentgenograms at regular intervals have shown at first an additional number of metastases, with some enlargement of the older ones and then a resting stage in which the findings varied little, the calcified character of the nummular shadows within the lungs changing little in density, outline, or size. During the period from March, 1930, to April, 1942, the patient has experienced from time to time attacks of mild dyspnea, cough, bloody sputum, but no sustained loss of weight; he has led a fairly active life but has done no labor. Several times he has been picked up by the omnipresent social worker, who, told of his cough and bloody sputum, has insisted under our municipal laws covering suspect infection with tuberculosis, that he should report to the tuberculosis sanitarium for examination. Repeated examinations of sputa failed to reveal tubercle bacilli. There has been no radiotherapy and no change in diet over that normally taken by his family. His weight varied between 129 and 138 pounds, averaged 134 pounds.

An examination on January 19, 1942, gave a weight of 130 pounds. He still had some chest pains and had had some hemoptysis 3 months before, none at time of examination. Stump scar and regional lymph nodes were normal. Roentgenograms, made of the skull, pelvis, and spine, were normal. The lungs still showed the same scattered calcific masses.

Fig. 2. Roentgen film of specimen after amputation and injection of vessels. The ray-like transverse projections of new bone formation seem typical of osteoblastic osteogenic sarcoma.

On April 10, 1942, 13 years after amputation and at least 12 years following the roentgenological demonstration of clinically diagnosed pulmonary metastases almost symmetrical in character in both lungs, no evidence of local recurrence in the stump or pelvic region has developed. The blood findings are red blood cells, 4,500,000; hemoglobin, 15.9 grams (99 per cent); and the white blood cells 14,100 with a differential count of neutrophils, 60 per cent; eosinophils, 2 per cent; lymphocytes, 34 per cent; and monocytes, 4 per cent. The serum phosphatase was 1.4 units per 100 cubic centimeters, a low adult average.

Pathologists believe that secondary tumors in the lungs are the result of direct nonmetastatic invasion or are true embolic metastases arising from malignant emboli carried into the pulmonary arteries. Both lungs are affected and pulmonary metastases found in about 30 per cent of fatal cases of malignant tumors.

Fig. 3. Roentgen film of chest May 9, 1929, before amputation. Only one suspicious area in the left upper lobe was considered as a possible metastasis, but after additional study it was believed not to be such.

Fig. 4. Roentgen film of chest March 6, 1930, 10 months after amputation, showing multiple areas of calcification in both lungs, which were diagnosed as osteogenic sarcomatous metastases.

In osteogenic sarcoma, blood borne pulmonary metastases occur in approximately 60 per cent of the fatal cases. As in other homogeneous tissues, most metastases are spherical in shape and quite sharply circumscribed, but when they occur in the subpleural area they may spread out in plaque-like or stellate growths which may encase the lung, as so well recorded by Le Count in 1909.

Ossifying pulmonary metastases of osteogenic sarcoma may contain areas of dense osteoid tissue or fully formed bone, which may undergo degenerative changes when the secondary growth is large. These changes include yellow caseation, hemorrhages, liquefactive softening, and pyogenic infections. Cavitation in a secondary growth may follow by discharge of a portion of it through a bronchus but this seldom is seen as compared to this finding in primary tumors of the lung.

A progressive multiplication of malignant tumor cells is the main factor in neoplastic infiltration—successive generations of cells are continuously "budded out" into surrounded tissues, and Willis warns that one must not rely too much on the motility of tumor cells and also recalls that their phagocytic powers are debatable. Certain biological factors may appear in the growth of secondary pulmonary deposits.

a. Soluble metabolites, capable of affecting surrounding tissues may expedite or pave the way for tumor invasion. In carcinoma a high lactic acid output has been found but there is no direct evidence that these products have any lytic or other damaging effects on the surrounding tissue.

b. Mechanical pressure from the secondary growth might set up degenerative or other damaging effects in the cells of the tumor invaded tissues.

c. Tumor cells may form specific heterolytic ferments but that the respiratory tract contains no digestive enzymes is a known fact.

d. Changes in tissue tension, dioxide and carbon dioxide content, or circulation may affect metastatic growths.

e. Changes in hormone or enzyme contents of the serum are said to affect secondary malignant tumor deposits as in bone.

Fig. 5. The chest September 22, 1937. There seems to be some change in the shadow just to the left of the heart as if a cavity or absorption of calcified material had occurred. Other masses in lung appear about as 7 years previously.

Fig. 6. The chest January 19, 1942. There may be slight change in the various nodules seen in the lungs, expressed in the film by density variation. On the whole the picture is nearly identical with previous findings.

However, malignant tumors retain a remarkable stability of type. Structure of the last formed secondary growths is in most instances very similar to the original tumor, even in minor details. Ewing says that in general there is a gradual loss of structure in metastatic tumors.

Some of the emboli of tumor tissue or cell masses in the lung may not grow but remain sterile and are absorbed or disappear, hence tumor embolism is not always true tumor metastasis. By penetrating pulmonary veins, they may become the source of systemic metastases leading to deposits in other tissues, as of the liver, brain, spleen, and of other organs as well as of other bones such as the spine and skull, and yet very little, if any, evidence of the first pulmonary metastatic growth may ever be either suspected or diagnosed clinically.

In discussion of delayed growth of metastatic tumors, Willis states that the majority of malignant tumors pursue a steady and uninterrupted course to a fatal termination, but that exceptions do occur as:

1. Tumors which, though frankly malignant in type and production of metastases, exhibit long duration with little or no impairment of the patient's health;

2. Tumors which, following surgical removal, recur locally only after a long period of freedom from disease;

3. Tumors which, in spite of completely successful local treatment followed by a long period of health, recur as metastases;

4. Tumors which exhibit spontaneous retrogression, partial or complete, *in their primary or metastatic situations*.

I believe that the patient here reported may fall into this first group. I have had others, with osteogenic sarcoma, who were in the third group, coming to death from metastases recognized after years, in other bones or organs, not always in the lungs—possibly on account of the reasons stated.

Chemical methods of early determination of metastases and a hope of restraining them were implied in Coley's reports in 1908 of 430 instances of varied types of sarcoma treated by mixed toxins, 28 of which had passed

through a period of 3 to 15 years since the disappearance of the tumor. He believed that the chances of success are certainly much higher after use of the toxins than the general percentage of 11 per cent of recoveries derived from his total series.

The transfer of a given type of cell from its origin in mesoblastic or other tissue by metastasis to lung or intestine might modify its exposure to circulation, dioxide and carbon dioxide supply. This change might lead to a more rapid maturation of the cell type involved, and in metastases from osteogenic sarcoma lead to a more rapid calcification, i.e., a more rapidly maturing form of the cells which might lessen or modify its malignant power in the new locus. In presence of calcification the malignant character of the active cell of the tumor, the true new-growth cell, might be throttled down or strangled. Consequently these metastases, after reaching a certain size, might cease to grow further. They may remain stationary and act simply as foreign body deposits, relatively innocuous, with decreased blood supply, often surrounded by a fibrous envelope, in pulmonary tissue. Another factor includes a change in the host's resistance as influenced by his reaction to the numerous metastases—a favorable or enhanced reaction aiding in limiting the amount of toxicity from the new-growth, without systemic expressions such as loss of weight, nutrition, and strength but with the development of antibodies which would aid in suppression of the spread of secondary deposits.

Maturity of the gonads might furnish an increased amount of hormone (testosterone) which likewise would act as a suppressor. Much experimental work on the effect of hormones on metastasis in man or transplanted tumors in mice has already been performed. Completely accepted and stabilized results which can be relied upon for clinical use have not yet been forthcoming. Huggins in his last paper is enthusiastic about reduction or obliteration of metastases from carcinoma of the prostate treated by orchidectomy. We have known for some time that metastases may be delayed or rendered less painful or even caused to diminish when treated by intensive roentgen therapy. One factor here may be that the roentgen-ray may destroy the secreting power of the testis during this treatment and an orchidectomy, as far as active hormones are concerned, may thus take place. Some genito-urinary surgeons, for example Kretschmer, do not favor this radical operation but use stilbestrol in quite large doses in an effort to suppress action of testosterone and thereby negative its effect, believing that they obtain a clinical subsidence and improvement, certainly diminution of pain, in the bone metastases.

Since Key's report on osteogenesis imperfecta (1926), the enzyme phosphatase has been found in the kidney, intestine, blood, bone, and other tissues. It possesses a reversible action best in a hydrogen-ion concentration of about 8 and with the presence of inorganic phosphate. Bodansky and Jaffe found that serum phosphatase is elevated in disease associated with excessive bone formation, and it has been stated (Woodard) that the elevation of phosphatase is proportional to both the degree of osteoplasia and the rate of growth of the tumor. This seemed to be a hopeful avenue of approach to diagnosis or even prognosis of bone metastases from osteogenic sarcoma. It was believed that, while an elevation of phosphatase is not a specific test for bone cancer, a very high serum phosphatase in osteogenic sarcoma usually indicates an extremely malignant tumor, whereas a low serum phosphatase indicates a slow growing and relatively benign tumor. Huggins is inclined to agree with this. However, serum phosphatase of nonosseous origin is raised by diet high in carbohydrates, also in obstructive jaundice, whereas it is lowered by starvation or high proteid diet.

A rise in serum phosphatase in some types of bone tumors is apparently caused by an over production of the enzyme by neoplastic tissue or adjacent periosteum and a removal of part of the enzyme by the blood stream. Malignant disease *per se* does not influence serum phosphatase. In 20 patients with benign bone tumor and osteomyelitis only 1 showed an elevated serum phosphatase (an aggressive giant cell tumor laying down bone). This suggests that bone forming characteristics of a tumor are of more importance than its malignancy in determining whether its

presence will give rise to an elevated serum phosphatase. The best example is Paget's disease, which always has a high phosphatase. In 14 instances of malignant disease not primary in, but metastatic to, bone, a high phosphatase was found ranging from normal to 45.5 the highest in metastases from carcinoma of the prostate and in the osteoblastic type of tumor. In osteolytic types of osteogenic sarcoma, in chondrosarcoma, and in endothelial myeloma, serum phosphatase may be normal or only slightly raised. However, in the case here reported in which the metastases were numerous and osteoblastic in type one might expect a high serum phosphatase, which was not found. Consequently, a correlation between serum phosphatase figures and the histological and radiological type of tumor does not seem close, and the phosphatase findings can be considered only as suggestive rather than definitely diagnostic of the type of tumor being studied. In theory also there might be an interpretation of the prognostic significance of phosphatase determination inasmuch as when an osteogenic sarcoma is present forming large quantities of serum phosphatase absorbed into the blood stream, removal of the tumor by operation (amputation or resection) or its inactivation by radiation or toxins should result in a fall of serum phosphatase. One might feel that the extent and constancy of the expected drop would be an indication of the effectiveness of the treatment—a late rise in serum phosphatase indicating the presence of recurrence or metastases. Clinical study of patients does not seem to back this up and little reliance can be placed on phosphatase determination as an aid in prognosis or of value in detecting pulmonary metastases. Healing callus about a pathological fracture resulting from osteogenic sarcoma might cause a high serum phosphatase.

Woodard and Higinbotham have studied the use of serum phosphatase determination as a help in evaluating radiation therapy of bone tumors for amputation either as an elective measure or while awaiting consent for surgical removal of the tumor. A tumor going on and spreading would be expected to give a continued raised phosphatase. Clinical tests of this method fail to show reliable results, although with added cases some help may be derived from this source of estimation and a failure of serum phosphatase to fall after amputation with or without radiation may be found due to residual portions of the tumor or undiscovered metastatic deposits.

These authors previously expressed an opinion that when a high serum phosphatase level is found associated with tumor showing little new bone formation, the rate of growth has outstripped the rate of deposition of calcium phosphate—which might be a restatement of our rather long standing clinical dictum that the rapidly growing lytic action tumor is the most malignant. Tissue phosphatase determination after amputation may help decide the point. They have employed radioactive phosphorus in treatment believing that the tumor picked it up and thus obtained local radium treatment. If the embolic masses from an osteogenic sarcoma will take up the radioactive phosphorus as readily as the parent mass, they propose its use to weaken these small groups of cells enough to prevent them from becoming established and from forming lethal metastases.

The patient reported here shows little spontaneous regression of tumor and metastases Spontaneous cures do follow carcinoma and even laboratory animals developing transplanted tumors may recover. Age, rapidity of development, and virulence of the tumor, interference with blood supply, febrile processes, artificial menopause or incomplete operations, are factors in these regressions, and the growth energy of the particular tumor must be considered. Handley said "The process of cancer is normally accompanied by regressive or curative processes. The recorded cases of natural repair of cancer, far from being anomalous and exceptional, merely illustrate more strikingly than usual the natural laws which govern every case of the disease."

In current parlance our patient seems to have something which is holding back the fatal termination of a disease we have come to dread as possessing a high mortality. Why could we not transfuse his blood into a patient with known osteogenic sarcoma and just beginning metastases to observe whether deterrent or curing effects followed? Such a patient has

just been in the hospital with known small metastases in the spine and lungs, but my patient departed for the summer before arrangements could be made for this test. Finally, if any group of such patients with prolonged life after known metastases from osteogenic sarcoma could be found, their blood might be given to a common blood or plasma bank, to be used as a therapeutic agent in other patients with incipient stages of the disease.

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THE GASTRIC MUCOSA AS AN ENDOCRINE GLAND

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THE therapeutic status of the patient with serious gastric ailments has been very little improved during the past two decades. Progress has been retarded due to the lack of knowledge concerning the relationship between gastrointestinal physiology and pathology, and the consequent inability to correlate the progress of disease processes in this important organ. The development of new methods of investigation into gastric physiology in humans and animals and the segregation and synthesis of several hormones have lent impetus to an additional conception of gastric mucosal activity. We believe it will prove helpful in explaining important pathological changes and lead to scientific curiosity and therapeutic advancement. The arbitrary division of digestion into chemical and nervous phases, although correct, in so far as it goes, is not sufficiently comprehensive of the physiological scope of the gastric mucosa, and therefore insufficient in explaining the pathological states which ensue. Up to the present time our attempted therapy in gastric ailments, both benign and malignant, has been notable for too frequent failure.

In recently published reviews on gastric carcinoma we called attention to the age incidence and sex discrepancy in this condition and suggested an endocrine basis. The new field of inquiry opened to gastroenterologists by the recently isolated and synthesized sex hormones was pointed out by Abrahamson and Hinton (1) and Hinton (30).

In an effort to correlate the marked changes in the content and character of the sex hormones which takes place during that period when gastric carcinoma is most prevalent, with the effects of age and sex on the physiology and pathology of the gastric mucosa, we reviewed those cases of benign gastroduodenal lesions which we had available. In the past 13 years, 1,171 cases of peptic ulcer have been registered, studied, and followed in the gastroenterological clinic of the medical and surgical services of the Fourth Divisions of Bellevue Hospital. Of these, approximately 10 per cent (112 cases) have been surgically treated and the remainder of the patients not operated upon carried under medical care. In reviewing age incidence and sex distribution of these cases, it was found that approximately 88 per cent (1,043) were males and only 12 per cent (128) were females, approximately 9 to 1. The incidence of duodenal ulcer was 89 per cent and of gastric ulcer 11 per cent (approximately 9 to 1). During this 13 year period approximately 337,500 males and 247,500 females were admitted to the Bellevue Hospital Medical and Surgical Clinics; a ratio of less than 3 males to 2 females.

Several recent reviews of large numbers of peptic ulcer cases showed a similar sex discrepancy. Collected data of approximately twenty-one authors, including all types of peptic ulceration, show an incidence of 8 to 9 males to one female, Nicholson and Miller and Miller and Elsom. McMullen, on reporting the x-ray findings in 4,400 peptic ulcers, noted the great preponderance of males and found that females reached the peak of incidence in the fourth and fifth decades and the males in the fifth and sixth decades. Our age incidence differs from this observation.

In view of the sex-linked character of this disease, we decided to re-examine the known effects of hormones on the gastric and duodenal mucosa and to add to this the clinical and experimental data we have gathered to date. Although we have had some experience with various hormones in the treatment of gastroenterological conditions, we have decided to present only those in which the follow-up has been of sufficient time (1 to 5 years) to make the observations of value.

For several years medical literature has contained clinical and experimental reports on the effects of the isolated hormones and vita-

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mins on the stomach and duodenum. In our attempt to collect and summarize this knowledge of hormonal effects on the gastroduodenal mucosa, we realize there are many omissions due to the limitations of time and space (inherent in an article restricted in size and scope).

The means by which the mucosa of the pylorus end of the stomach affects the production of secretions from the cardia and fundus have not as yet been completely established, but there is sound experimental evidence to show that the hormone "gastrin" Edkins (20-21), and Koch, Luckhardt and Keeton (38) is produced and thrown into the blood stream by the pyloric mucosa. Because of the similar action of histamine upon the gastric mucosa, several authors believed this hormone to be histamine; however, recent work on isolated and denervated gastric pouches with histamine-free extracts demonstrates the true hormonal character of the internal secretion of the gastric mucosa (Friedman, Gray (28), Babkin, and Best and Taylor).

Although some of the fundamental physiological aspects concerned with the "gastrin" hypothesis remain unsolved, experimental evidence accumulated during the last few years seems to indicate rather definitely that the mucosa of the pyloric portion (of the stomach) is responsible for the endocrine secretion of the gastric mucosa. Hormones from the intestine, secretin (Ivy, 33), cholycystokinen (Ivy, 34), and enterogastrone (Friedman) also affect the gastric mucosa. It has been shown that the internal secretion of enterogastrone, which depresses gastric secretion (Day and Komarov), activates and stimulates the duodenal mucosa.

Recent experiments and clinical findings show that the gonadotropic substances in the blood stream influence the activity of the gastric mucosa. The anterior pituitary-like fraction of pregnancy urine depresses gastric secretion (Culmer, Atkinson and Ivy, and De Lisi) believed that the depression of gastric secretions following the administration of anterior pituitary-like substance, is secondary to its effect upon the thyroid and ovaries.

Increased acid secretion in dogs has been noted in transplanted gastric pouches during lactation (Klein). Gastric hypersecretion has been noted following parturition (Hollander). Gastric acidity is reduced during pregnancy. Peptic ulceration rarely occurs during this period and if it was present prior to gestation, a remission usually takes place (Arzt, and Strauss and Castle). This was thought to be due to increased blood estrogen (Winkelstein, 75), but further observations following estrogen injections in animals and humans have failed to verify this finding (Atkinson and Ivy).

It is a fundamental tenet of the concept of internal secretion that the endocrine organs secrete chemical hormones which have specific effect, whether their action is on other endocrine organs, or a tissue group, or on all the tissues of the body. Since we assume that the gastric mucosa has an internal endocrine secretion into the blood stream as well as an external endocrine secretion, it should be considered as an hormonal gland and its activities subject to the changes which effect other similar glands. This conception will allow for the study and explanation of physiological and pathological changes now obscure.

INTERRELATIONSHIP OF HORMONES EFFECTING GASTRIC MUCOSA

There is ample evidence to show that thyroid activity has a definite effect on the sex hormones. Thyroxin suppresses estrin, and estrogen depresses the thyroid while androgen does not have this effect. Thyroxin increases the activity of the gonadotropic factor. Marine (44) points out that there is a thyroid-gonad effect in addition to the pituitary-gonad effect.

It is important to note that the corpus luteum hormone, progesterone, is the only hormone present in females which has not been found in males. It promotes the renal excretion of estrogen (Smith and Smith, 67), and has a corticomimetic action (Wells and Greene). There can be no doubt that it has a definite effect on the general hormone balance and is a factor in the estrogen-androgen ratio stabilization in the female. Attempts have been made to establish its relationship to gastric mucosal activity (Manville and Munroe), but no proof of this action is as yet forthcoming.

Hormones in the blood stream not only have a definite effect upon other hormonal gland activities, but also are related to the nature and content of several of the mineral and chemical constituents in the blood plasma. In normal girls at puberty, the calcium and nitrogen balance is depressed by the administration of estrone (Johnston). In premenopausal and postmenopausal diabetic women, estrogen lowered the insulin requirements (Spiegelman). The excretion of sodium chloride and retention of potassium is influenced by injections of testosterone proportionate (Kenyon, Sandiford et al, 36).

RELATIONSHIP OF ENDOCRINE TO VITAMIN ACTIVITY ON GASTRODUODENAL MUCOSA

The information on vitamin is quoted to show the close linkage between vitamin intake and hormone activity. It is known that the anabolism and metabolic activity of many endocrines are dependent upon the presence of various vitamins, either as an integral part in its metabolism, or as an intermediary link in the resulting activity.

Most have agreed that vitamin C plays a fundamental rôle in the process of wound healing. The close relationship between the adrenal glands and vitamin C storage and their general effect upon epithelial growth and body metabolism have been pointed out by Murlin (54). Although the adrenal cortical hormone was found to have no demonstrable replacement activity in experimental avitaminosis B, the apparent partial replaceability of vitamin C by adrenal cortical preparations reported by several observers is due to the presence of ascorbic acid in such extracts. Crystalline vitamin C is more effective when administered intraperitoneally than by mouth. The other considerations which have led various observers to assume the existence of an intimate relation between the adrenal cortex and vitamin deficiences are explicable on the assumption that the hormone and vitamins are necessary for the proper functioning of a great number of organs and tissues (Grollman and Firor). Hunt believes that vitamin C deficiency is common in patients suffering from peptic ulcer and from carcinoma of the stomach.

The presence of large amounts of vitamin E in neoplasms of the gonads and a close relationship between vitamin E and estrogens have been claimed. Although several workers dispute the directness of this relationship, these refutations have been recently answered by Shute.

Although to date insufficient corroborative work to prove this contention is available, vitamin H (biotin) causes a lowering of metabolic rate and a recession in tumor growth. Induced biotin deficiency gives a possible explanation to the occasional spontaneous recession in malignancy. The experimental work on rat primary liver carcinoma induced by feeding "butter yellow" and its relationship to biotin is interesting but not conclusive (West and Woglon).

Two hundred patients with peptic ulceration were given large doses of vitamins A and D in the form of cod liver oil concentrate of high vitamin content (approximately 50,000 units of A and 12,000 units of D per ounce). This was administered 1 ounce three times a day. Although these patients showed subjective and objective improvement, gain in weight, reduction in pyrosis, abdominal pain, etc., they all required further medication for the control of their gastrointestinal symptomatology and no specific effects on the gastric mucosa could be noted.

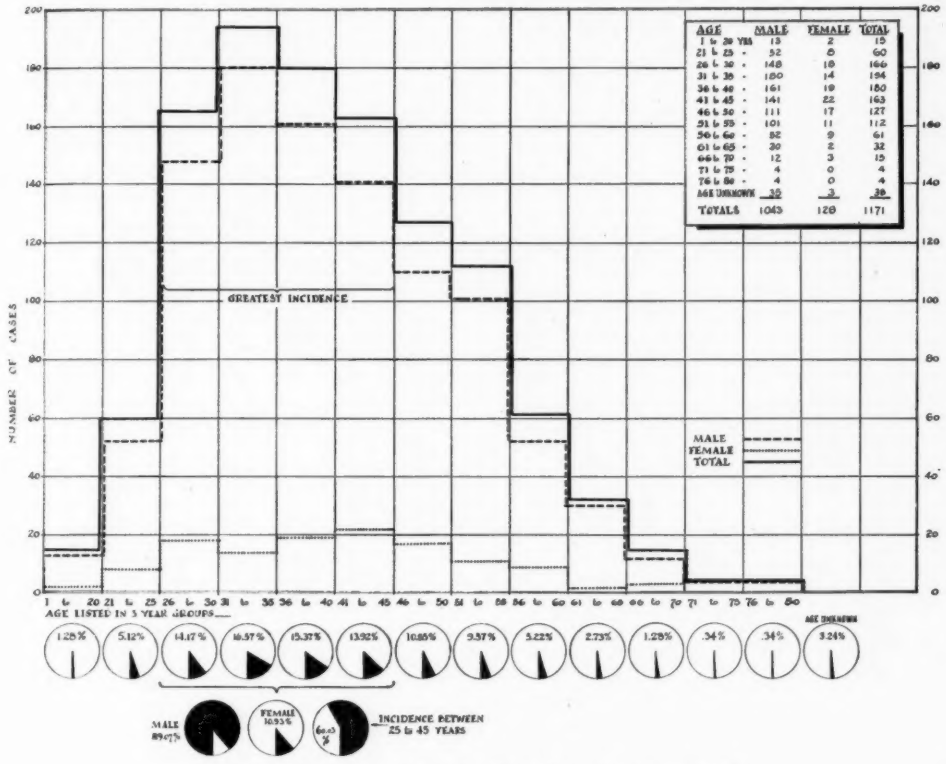
Forty patients all with positive x-rays for peptic ulcer were placed on 6 gram tablets of yeast concentration containing at least 50 international units of B_1 and 50 Sherman units of G; 2 tablets three times a day were administered. Other factors in the vitamin B complex were present, but their exact unitage was not noted. Although there was an increase in weight, appetite, and improvement in their general health, the great majority required further medication, and no specific information concerning its effect is forthcoming.

Eighteen patients were placed on cevitamic acid (vitamin C) 25 milligrams, three times daily for 2 to 4 week periods. No extraordinary clinical or roentgenographical improvement occurred in this group with the exception of 2 patients whose symptoms seemed completely alleviated clinically and by x-ray. On closer examination, both of these patients proved to

TABLE I.—RESULTS IN TWENTY-FIVE CASES OF PEPTIC ULCERATION TREATED WITH THYROID AND THYROXIN

No.	Age	Duration of symptoms	X-ray previous to treatment	B.M.R.	Thyroid gr. ½–1 t.i.d.	Thyroxin gr. 1/60 weekly	Dinitrophenol ½–1 t.i.d.	Time over which medication was given	3 mo.—6 mo. follow up x-ray	6 mo.—1 year follow up	1 year—2 years follow up x-ray	Remarks
1	34	6 yrs.	Duo +	−16	+	+	+	3 mos.	Unimproved +	Improved	Unimproved +	Wassermann + Spinal fluid +
2	40	8 yrs.	Duo +	+11	+	+	+	3 mos.	Unimproved +	Improved	Unimproved +	Required luminal
3	28	9 mos.	Gastroenter. marginal	+12	+	+	+	3 mos.	Unimproved +	Unimproved	Unimproved +	Required luminal
4	31	1 yr.	Duo + Gastric +	0	+	+		2 mos.	Asymptomatic —	Asymptomatic	Asymptomatic —	Required luminal
5	44	3 yrs.	Duo +	−10	+	+		1 yr.	Asymptomatic +	Improved	Recurrence 18 mos. +	Moderate hemorrhage
6	51	3 yrs.	Duo +	No data	+	+	+	2 mos.	Improved +	Improved	Died from coronary closure	
7	27	1 yr.	Gastric +	No data	+	+	+	1 yr.	Asymptomatic —	Improved	Improved —	
8	31	1 yr.	Duo +	+16	+	+		1 mo.	Unimproved +	No data	No data	
9	29	5 mos.	Duo +	+ 4	+	+	+	6 mos.	Improved +	Unimproved	Recurrence 2 yrs. +	Required luminal
10	36	2 yrs.	Duo +	Unsatisfactory	+	+		6 mos.	Improved +	Unimproved	No data	
11	39	6 wks.	Unsatisfactory	No data	+	+		3 mos.	Unimproved +	Unimproved	No data	
12	37	6 yrs.	Gastroenter. marginal +	+10	+	+		3 mos.	Unimproved +	Unimproved	Unimproved +	
13	51	5 yrs.	Duo +	Unsatisfactory	+	+		3 mos.	Unimproved +	Unimproved	Unimproved +	
14	62	10 yrs.	Duo +	−16	+	+		1 yr.	Asymptomatic —	Asymptomatic	Asymptomatic —	
15	47	3 yrs.	Duo +	−12	+	+		2 mos.	Unimproved +	No data	No data —	
16	32	2 yrs.	Duo +	− 4	+	+		3 mos.	Unimproved +	Asymptomatic	Recurrence +	
17	40	4 yrs.	Duo +	− 8	+	+		8 mos.	Asymptomatic —	Asymptomatic	Asymptomatic —	
18	29	1 yr.	Duo +	No data	+	+		5 mos.	Asymptomatic +	Improved	Improved +	
19	43	10 yrs.	Gastric res. marginal	+11	+	+	+	1 mo.	Unimproved +	Improved	Unimproved +	Known to have syphilis
20	36	14 yrs.	Duo +	+ 3	+	+		2 wks.	Unimproved +	Recurrence 6 mos.	Recurrence +	
21	54	8 yrs.	Duo +	No data	+	+		2 mos.	Unimproved +	Recurrence 2 mos.	Recurrence +	Subtotal gastrectomy
22	32	1 mo.	Duo +	+ 4	+		+	6 mos.	Improved —	Improved	Improved	
23	41	2 yrs.	Duo +	Unsatisfactory	+		+	1 mo.	Recurrence			Perforation. Heroin addict
24	40	1 yr.	Duo +	−11	+			2 mos.	No data	No data	No data	
25	22	2 yrs.	Duo +	No data	+	+		3 mos.	Unimproved +	Improved	Unimproved +	

Improved indicates no other medication required.
Cases 3, 8, 9, 18 were females.
Gastroenter. marginal means gastroenterostomy with marginal ulcer.
Gastric res. marginal means gastric resection, marginal ulcer.



AGE	MALE	FEMALE	TOTAL
1 to 20 YRS	13	2	15
21 to 25 -	52	8	60
26 to 30 -	148	18	166
31 to 35 -	180	14	194
36 to 40 -	161	19	180
41 to 45 -	141	22	163
46 to 50 -	111	17	127
51 to 55 -	101	11	112
56 to 60 -	52	9	61
61 to 65 -	30	2	32
66 to 70 -	12	3	15
71 to 75 -	4	0	4
76 to 80 -	4	0	4
AGE UNKNOWN	30	8	38
TOTALS	1043	128	1171

Chart 1. Showing sex and age incidence in peptic ulcer patients.

have subclinical scurvy as a result of prolonged stringent ulcer diet during and prior to coming for treatment. Since additional medication was required in 16 patients no definite information on the gastroduodenal mucosa can be derived from this group. Several of the patients were given parenteral injections of crystalline cevitamic acid in addition to the oral administration, with no further beneficial result.

Our previous work on epigastric symptoms in hypothyroidism (Hinton) showed that the gastric hypermotility which accompanied abdominal pain in this condition could be relieved by the administration of thyroid. Moehlig believes these patients are benefited by thyroid therapy because of the thyroid-hypthalmic-gastrointestinal relationship. While an enormous but inconclusive literature exists on the relationship between the gastrointestinal tract, thyroid gland and sex glands, recent studies by Marine and Rosen have shown a direct relationship between Graves' disease, myxedema, and androgen-estrogen excretion. We have followed a group of 25 patients, all suffering from peptic ulcerations (x-ray positive), who have been placed on combinations of thyroid, ½ to 1 grain three times a day, by mouth, and thyroxin intravenously 1/60 grain weekly. In an attempt to confirm specificity of the actions of these drugs on the gastrointestinal mucosa and eliminate rise in basal metabolic rate, some of these patients were placed on dinitrophenol. We fully realize the difficulties in the scientific interpretation of results of this type of clinical experimentation; the dangers of drawing false conclusions are obvious.

Cases 3, 8, 9, 18 were females.
Gastroenter. marginal means gastroenterostomy with marginal ulcer.
Gastric res. marginal means gastric resection, marginal ulcer.

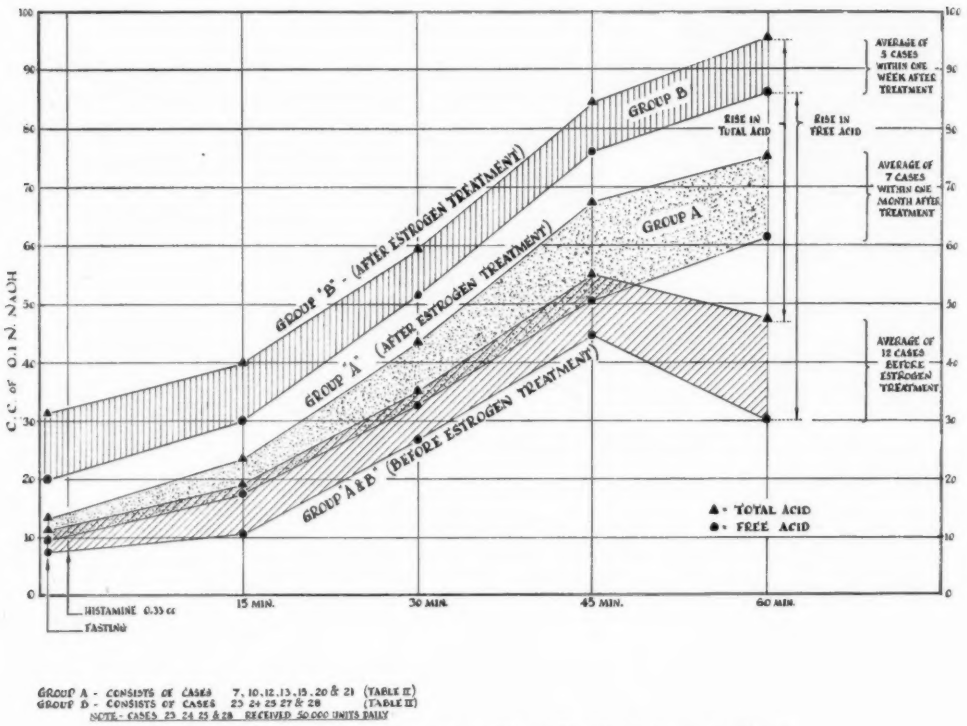

C.C. of 0.1 N. NaOH
GROUP 'B' - (AFTER ESTROGEN TREATMENT)
GROUP 'A' (AFTER ESTROGEN TREATMENT)
GROUP A & B (BEFORE ESTROGEN TREATMENT)
GROUP A
GROUP B
RISE IN TOTAL ACID
RISE IN FREE ACID
AVERAGE OF 5 CASES WITHIN ONE WEEK AFTER TREATMENT
AVERAGE OF 7 CASES WITHIN ONE MONTH AFTER TREATMENT
AVERAGE OF 12 CASES BEFORE ESTROGEN TREATMENT
▲ - TOTAL ACID
● - FREE ACID
HISTAMINE 0.33 cc
FASTING
15 MIN.
30 MIN.
45 MIN.
60 MIN.
GROUP A - CONSISTS OF CASES 7, 10, 12, 13, 15, 20 & 21 (TABLE II)
GROUP B - CONSISTS OF CASES 23 24 25 27 & 28 (TABLE II)
NOTE - CASES 23 24 25 & 28 RECEIVED 50,000 UNITS DAILY

Chart 2. Graph showing increase in gastric acidity after estrogen treatment.

The basal metabolic rate in this group was within normal limits. There were 4 female and 21 male patients. Three patients had been operated on and showed marginal recurrent ulceration, 2 having had gastroenterostomies, and 1 a gastric resection 2 to 5 years previously. Results of gastric analysis done prior to and following treatment showed that any changes which occurred were within the percentage of error. (At the end of the 3 months follow-up, 6 patients were cured, 4 both symptomatically and by x-ray report; 5 patients were symptomatically improved but the x-rays remained positive. A total of 10 patients seemed improved by medication at a 3 months follow-up. During the following year, there were 7 patients who had recurrences of their acute symptoms and one with perforation. Several of the patients improved, on later examination became unimproved and 2 came to operation.)

In an effort to determine whether any of the improvement noted was due to a simple increase in basal metabolic rate, 5 of the improved cases and 4 of the unimproved cases were placed on dinitrophenol, ½ to 1 grain three times a day, for a period of 1 to 3 months. No difference was noted in those placed on thyroid and those placed on dinitrophenol. Although it is hardly possible to state from these clinical and x-ray results the total effect of thyroid and thyroxin upon the gastric mucosa, we can observe that the results both therapeutically and upon the course of the pathological condition were poor and variable and about equal to a controlled group on other forms of therapy for peptic ulcer.

Several effects of sex hormones on the gastrointestinal mucosa have been noted. Interest has been stimulated to attempt to correlate the relationship between the ductless glands and peptic ulcer. Sandweiss and asso-

ciates have collected data to substantiate the observation that pregnant women are seldom afflicted with peptic ulcer and concluded that the anterior pituitary-like hormone depressed the gastric secretion and was a protective factor against peptic ulcer. Winkelstein (74) treated a group of 20 menopausal patients having ulcer symptoms with estrogen. His results were inconclusive and it was not possible for him to determine whether this was a specific effect on the gastric function or whether it was a secondary effect brought about by a general symptomatic improvement due to relief of the neurovascular symptoms of the menopause. Others believe that the posterior pituitary gland is implicated in the production of peptic ulcer. Experimentally they report that the removal of the posterior portion of the pituitary gland of dogs increased gastric secretion after histamine injection and inhibited gastric secretion with large doses of pituitary (Metz and Lackey).

In an attempt to ascertain the effect of estrogens on the activity of gastric and upper intestinal mucosa, we have placed 29 males with peptic ulcerations of the duodenum on various dosages of estrogenic substance (theelin in oil).

In each case from 13 to 31 injections were given, 6,000 to 50,000 international units being given daily intramuscularly. A careful investigation of the clinical history and physical findings together with laboratory data such as repeated x-ray examinations, gastric meal tests, hematological studies and gastroscopy, and blood and urine studies for estrogen determinations were performed. These cases have been carefully followed over a 1 to 5 year period.

All 29 patients were males; average age 39.2 years. All patients had positive x-rays for duodenal ulcer. The average length of time since the diagnosis was established and the patient was placed under treatment in this clinic was 2.9 years (several patients had refused operation).

Injections were given 6 days per week, intramuscularly (buttocks).

Of the 29 cases, 28 were followed for 1 to 3 months; 21 for 6 months to 1 year; 18 for 1 to 3 years; and 11 for 3 to 5 years.

Clinical results	X-ray
28 cases followed for 1 to 3 months.	
1 recurrence of severe symptoms (worse).	less 9 negative x-rays following treatment
1 unimproved	plus 17 positive x-rays following treatment
8 good results. Mild residual gastrointestinal symptoms	plus 3 evidence of healed lesion, with no activity
15 asymptomatic following treatment	
1 results unknown	
21 cases followed 6 months to 1 year	
6 recurrences of severe symptoms	less 1 negative
4 unimproved	plus 18 positive
6 good. Mild residual gastrointestinal symptoms	10 unknown
4 asymptomatic	plus evidence of healed lesion, no activity
9 results unknown	
19 cases followed 1 to 3 years[1]	
7 further recurrence of symptoms	less 3 negative
11 cases in all had recurrence of symptoms	plus 14 positive
2 unimproved	plus 1 evidence of healed lesion, no activity
5 good results. Mild residual gastrointestinal symptoms	
2 asymptomatic	
2 operated upon (1 asymptomatic) (1 dead after operation)	
11 cases followed for 3 to 5 years	
2 further recurrences of symptoms	less 3 negative x-rays (2 operated cases)
8 cases in all had recurrence of symptoms	plus 8 positive
3 good	
3 asymptomatic	
3 unimproved	
1 operated upon (asymptomatic)	

[1] Two cases with former good results and recurrence had 10 further injections each 1,000 units of theelin, 10 and 12 months, respectively, after the original injections. These patients are reported as good or improved, but with occasional gastrointestinal upset, and unimproved, respectively, 1 to 3 years following treatment.

Twelve patients were given gastric test meals both before and after treatment; in 7 (group A) the second test was performed at varying intervals following treatment (2 weeks to 1 month). Although several were above normal limits prior to treatment, the free and total acid either remained above normal or was perceptibly higher following treatment. No cases showed a fall in either free or total acid despite clinical and x-ray improvement.

In 5 cases (group B) gastric test meals were performed 1 day to 1 week prior to theelin injection. The method of gastric analysis employed was as follows:

The patient came in without breakfast. A Levine tube No. 18 was passed through the nose into the stomach, and a fasting specimen of about 30 c.c. collected and labeled as such. A test meal specimen of about 10 c.c. was then taken and labeled No. 1, and after that at 15 minute intervals additional specimens, to a total of 4 were collected and labeled No. 2, No. 3, and No. 4, respectively.

In group B 3 cases showed a moderate degree of hyperacidity and 2 cases showed normal gastric acidity prior to estrogen injections. All showed a tremendous increase in free and total acidity following the injections of estrogen; increase of 40 to 180 per cent free acid and an increase of 22 to 164 per cent total acid (Chart 2).

We are fully aware of the many difficulties and pit falls present in attempting to evaluate the results of any treatment for peptic ulcer. Spontaneous remission is a characteristic of this condition. However, our cases were selected because of their chronicity and their lack of response to other forms of therapy. We have under treatment several groups of patients who act as controls and who have been receiving oral and parenteral medication during the same period. Of 29 cases, 28 were followed 1 to 3 months (Table II) and 15 cases, 53.5 per cent, asymptomatic and 8 cases (28.6 per cent) improved sufficiently not to require further medication, a total of 23 cases (82.1 per cent). This compared favorably with control groups which varied from 38 per cent to 70 per cent of the cases showing a comparable improvement. Twelve cases, 42.8 per cent, showed reversal of previously positive x-rays. Control groups of similar cases (best results) showed 20 per cent reversals.

At 6 months to 1 year follow-up patients were asymptomatic and in 6 the results were considered good and at 1 to 3 years only 2 patients remained asymptomatic and 5 were considered to have good results. By this time only 3 x-rays were negative. The course taken by these patients shows the transitory character of the change influenced by hormone administration and the extreme importance of a long, careful follow-up in this condition to avoid being misled and making faulty interpretations.

Our only conclusions concerning the daily parenteral injection of estrogen are that it causes a higher percentage of remission in chronic duodenal ulcer (lasting from 5 to 10 months), than found in controls. Although the number of cases in this group is too small a sample for mathematical calculation, the results seem clear cut. Of greater importance than the subsidence of symptoms (in the clinical course of peptic ulceration) is the healing of the duodenal lesion. This change in pathology occurred (as evidenced by x-rays) in the presence of a markedly increased free and total acidity (Chart 2). It would lead one to doubt the present thought concerning the relationship between the healing of a duodenal ulcer and the lowering of gastric acidity. Others, including Konjetzny, who have experimented on an entirely different basis, have come to similar conclusions, at least as far as antacid therapy is concerned (Schiffrin; and Schindler, Necheles and Gold, 65). Although increased gastric acidity may cause erosions in the experimental dog's stomach, when the blood supply to the organ has been severed, this is not the case in unoperated humans, Schindler et al. (65). In our series estrogens raised the gastric acidity in males and in the presence of this raised acidity caused a transitory symptomatic, 82.1 per cent, and in many cases x-ray cure of the peptic ulceration, 42.8 per cent.

In 8 cases blood and urine studies for estrogen determination were performed. In all but one the urine estrogen output increased following estrogen administration. Unfortunately, simultaneous blood and urine cholesterol and androgen determinations were not made. Since androgen determinations are necessary to gauge the androgen-estrogen ratio and since it is our belief that high urine cholesterol determination may represent an increased hormone excretion, as a result of degradation synthesis of hormones to cholesterol, this portion of the work will have to be repeated.

Seven patients had gastroscopic examinations prior to estrogen administration. Since only 2 patients (both of whom showed a normal gastric mucosa despite the increased gastric acidity) had gastroscopic examinations following treatment, further evidence of mucosal changes by direct vision is necessary.

This is being gathered and will be presented in a separate publication.

A case which is not part of our series is of interest in this regard:

A 57 year old anemic female complained of epigastric distress, distention, pyrosis, and loss of appetite. Gastrointestinal series showed a deformity of the stomach attributed by the roentgenologist as atrophic and hypertrophic gastritis. Suspecting malignancy, this patient was examined by gastroscope and a diagnosis of atrophic gastritis was made. The patient was placed on theelin in oil, 10,000 units twice weekly for 24 injections. Following and during treatment she became asymptomatic and has remained so (19 months follow-up). X-ray examination and gastroscopy of stomach 1 year following treatment were revealed as "no sign of abnormality."

Special attention to endocrinopathies resulting from large doses of estrogens was given. Three patients developed gynecomastia; 2 developed loss of libido. These manifestations lasted from 2 weeks to 2 months following treatment and then completely disappeared. Examination of the prostate and testicles on all patients showed no evidence of change or abnormality. Experience of several observers (Auchincloss and Haagensen and Gemmell and Jeffcoate) has emphasized the inherent dangers in continual hormone injection, especially in large doses. We have no intention of recommending hormone therapy as routine treatment in peptic ulcer and would add our warning to that of others on the possible pathological and carcinogenic activity of these powerful agents. It is possible that, in a patient with a threatening perforation on whom operation was not feasible and in other indicated cases, hormone therapy would be applicable.

Pathological sections on the resected stomachs of the 3 cases which came to operation because of advanced or recurrent peptic ulceration, following a series of estrogen injections, showed that with the exception of the peptic ulcer which had recurred at its original site in the duodenum, the entire gastric mucosa was within normal pathological limits.

Estrogens do not depress the quantity and acidity of gastric secretion. In fact we find, quite to the contrary, that they increased the free and total acidity in those patients who have been followed up. At present, we know that estrogens have a definite action on the gastric mucosa, whether direct or indirect. Only a small part of the character and extent of such action has been determined.

A similar group of patients to those placed on estrogen therapy is at present receiving male sex hormone; both the number of cases and the length of time they have been studied are insufficient to give any definite results, and the same may be said for the other groups. These will be presented when sufficient time has elapsed.

Although we have several patients receiving gonadotropic hormone (anterior pituitary-like substance), our results are so variable that we are not prepared to report at present. In none of the cases in which these preparations were used was there a consistent change in the character or volume of the gastric secretions, nor in the healing of the ulcerative lesion. It is possible that these results are due to the fact that the dosage given each patient was too little (extracts of low unitage) and this work will have to be repeated.

CARCINOGENIC FACTORS INFLUENCING GASTRIC MALIGNANCY

In our recent report (1) of statistical and diagnostic data on cases of carcinoma of the stomach, the discouraging status was emphasized. The magnitude and seriousness of this problem is realized when one is confronted with a condition that accounts for from one-fourth to one-third of the total deaths from carcinoma annually (Livingston and Pack). It is difficult to determine whether the increasing frequency of cancer of the stomach is due to its more accurate recognition. Another factor, the average age at death being postponed so that the patient lives through a cancer age, is more important. The fact that stares us plainly in the face is that the attack rate of gastric malignancy is increasing and accounts for thousands of deaths yearly, and this is the primary reason why new and more successful approaches to this problem are imperative. The disparaging outcome following surgery has been noted, and the need for different approach of this problem is apparent.

TABLE II.—TWENTY-NINE CASES OF DUODENAL PEPTIC ULCER IN MALES TREATED WITH PARENTERAL ESTROGENIC SUBSTANCE (THEELIN)

No.	Age	Years treated in clinic prior to theelin injection	Total number injections of theelin	International units of theelin per injection	X-ray results immediately before treatment	1–3 months following treatment		6 mos.–1 year following treatment		1–3 years following treatment		3–5 years following treatment		Further treatment
						Clinical results	X-ray results	Clinical results	X-ray results	Clinical results	X-ray results	Clinical results	X-ray results	
1	38	3	20	4000	+	Asymptomatic	+	Good	+	Good	+	Good	+	
2	44	2	21	4000	+	4 mos. Recurrence	+	Recurrence	+	Recurrence	+	Recurrence	+	Medical
3	41	3	18	6000	+	Asymptomatic	—	No data	No data	No data	No data	No data	No data	
4	32	5	30	4000	+	Unimproved	+	Recurrence	+	Good	+	Unimproved	+	10 additional injections 1000° units theelin
5	46	3	21	6000	+	Good	+	Asymptomatic	+	Recurrence	+	Asymptomatic Operation	Gastric	Surgical resection
6	40	2	18	6000	+	Asymptomatic	+	No data	No data	No data	No data	No data	No data	
7	29	6	20	6000	+	Asymptomatic	—	Unimproved	+	Unimproved	+	Unimproved	+	Medical
8	60	2	19	6000	+	Asymptomatic	+	No data	No data	No data	No data	No data	No data	
9	39	1	30	6000	+	Good	+	Recurrence	+	Good	+	Unimproved	+	10 additional injections 10,000 units theelin
10	46	3	21	10000	+	Good	—	Good	+	Good	—	Good	+	None
11	34	2	20	6000	+	Unimproved	+	No data	No data	No data	No data	No data	No data	
12	34	4	18	6000	+	Asymptomatic	—	No data	No data	No data	No data	No data	No data	
13	32	2	21	10000	+	Asymptomatic	+	Recurrence	+	Operation—died				
14	47	3	21	10000	+	Unimproved	+	No data	No data	No data	No data	No data	No data	Medical

Note: It should be taken into consideration that upon recurrence of symptoms, oral medication was resumed.
Good. Definitely improved with mild residual gastrointestinal symptoms. No further medication required.
Unimproved. Medication caused no change in gastrointestinal symptoms.
Recurrence of previous severe ulcer symptoms.
No data. Patients did not return for follow-up studies.
X-ray results: ⊙=ulcer present.
± =evidence of healed lesion; no activity.
— =no pathology noted.

± =evidence of healed lesion; no activity.
− =no pathology noted.

TABLE II.—TWENTY-NINE CASES OF DUODENAL PEPTIC ULCER IN MALES TREATED WITH PARENTERAL ESTROGENIC SUBSTANCE (THEELIN)—Continued

No.	Age	Years treated in clinic prior to theelin injection	Total number injections of theelin	International units of theelin per injection	X-ray results immediately before treatment	1–3 months following treatment		6 mos.–1 year following treatment		1–3 years following treatment		3–5 years following treatment		Further treatment
						Clinical results	X-ray results	Clinical results	X-ray results	Clinical results	X-ray results	Clinical results	X-ray results	
15	33	1	18	10000	+	Asymptomatic	−	Asymptomatic	−	Asymptomatic	−	Asymptomatic	−	None
16	49	2	21	10000	+	Good	+	Good	+	No data	No data	No data	No data	
17	26	1	17	6000	⊙	Asymptomatic	+	Recurrence	+	Asymptomatic Operation	— Operation	Asymptomatic Gastric	— Resection	
18	50	7	18	6000	⊙	Good	+	Good	+	Good	+	Good	+	Medical
19	43	3	19	10000	⊙	Unimproved	+	Recurrence	+	Unimproved	+	Recurrence		Medical
20	35	2	24	10000	⊙	Asymptomatic	+	Unimproved	+	Recurrence	+	No data	No data	Medical
21	37	2	26	10000	⊙	Asymptomatic	−	No data	No data	No data	No data	No data	No data	
22	29	1	18	10000	⊙	No data	−	No data	No data	No data	No data	No data	No data	
23	52	2	13	50000	⊙	Good	+	Unimproved	+	Recurrence	+	No data	No data	
24	47	1	14	50000	⊙	Asymptomatic	+	Good	No data	Recurrence	+	No data	No data	
25	41	2	14	50000	⊙	Good	−	Asymptomatic	+	No data	No data	No data	No data	
26	36	2	21	10000	⊙	Asymptomatic	−	Recurrence 5 mos.	Hospitalized			No data	No data	
27	49	1	21	10000	⊙	Asymptomatic	±	Asymptomatic	+	Asymptomatic	+	No data	No data	
28	50	2	13	50000	⊙	Good	±	Good	No data	Recurrence	Hospitalized		No data	
29	44	1	20	10000	⊙	Asymptomatic	±	Unimproved	+	Recurrence	+	No data	No data	Hospitalized

Note: It should be taken into consideration that upon recurrence of symptoms, oral medication was resumed.
Good. Definitely improved with mild residual gastrointestinal symptoms. No further medication required.
Unimproved. Medication caused no change in gastrointestinal symptoms.
Recurrence of previous severe ulcer symptoms.
No data. Patients did not return for follow-up studies.
X-ray results: ⊙ =ulcer present.
± =evidence of healed lesion; no activity.
− =no pathology noted.

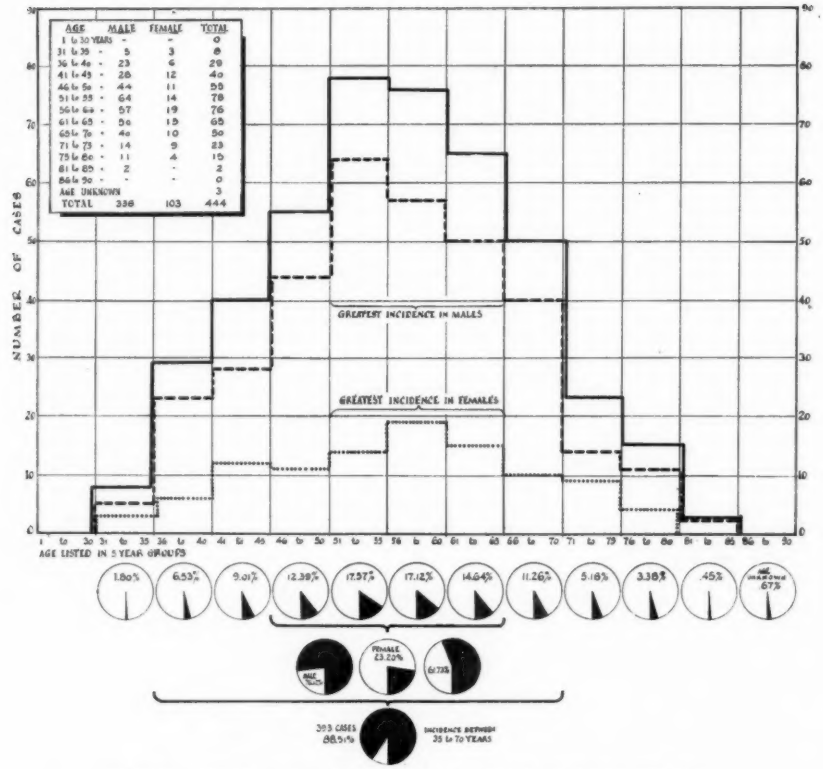

AGE MALE FEMALE TOTAL
1 to 30 YEARS - - 0
31 to 35 - 5 3 8
36 to 40 - 23 6 29
41 to 45 - 28 12 40
46 to 50 - 44 11 55
51 to 55 - 64 14 78
56 to 60 - 57 19 76
61 to 65 - 50 15 65
66 to 70 - 40 10 50
71 to 75 - 14 9 23
75 to 80 - 11 4 15
81 to 85 - 2 - 2
86 to 90 - - - 0
AGE UNKNOWN 3
TOTAL 336 103 444
NUMBER OF CASES
GREATEST INCIDENCE IN MALES
GREATEST INCIDENCE IN FEMALES
AGE LISTED IN 5 YEAR GROUPS
1.80%
6.53%
9.01%
12.39%
17.57%
17.12%
14.64%
11.26%
5.18%
3.38%
.45%
67%
FEMALE 23.20%
67.78%
388 CASES 88.5%
INCIDENCE BETWEEN 35 to 70 YEARS

Chart 3. Showing sex and age incidence in gastric carcinoma patients.

Although several claim moderate success Balfour (7) and Gray (27) in the surgical cure of gastric malignancy, recent reviews by Boyce, Mullen, and Oughterson, are in agreement with our findings that the outlook in gastric carcinoma in the general population is a very dismal one. A further study by one of us (J. W.H.) comparing selected with unselected cases verifies the finding that the operability and resectability in gastric cancer is definitely influenced by the selection of cases (Saypol and Hinton).

There have been 444 cases of carcinoma of the stomach on the Fourth Medical and Surgical Divisions of Bellevue Hospital during the last 20 years. These cases are charted as to age and sex. The chart is based on consecutive admissions, with males and females divided into 5 year groups. The preponderance of males over females, more than 3 to 1, is conspicuous as illustrated in Chart 3.

Over 88 per cent of the cases fall between the ages of 35 and 70 with the peak of incidence occurring in males between 50 and 55, and females between 55 and 60. The age incidence and sex discrepancy in gastric carcinoma are two facts which stand out in almost every large series reported in recent years (Balfour and Hargis, 8), Minnes and Geschickter). It is in an attempt to clarify and explain these two facts that we are presenting information contained in the recent physiological, biochemical, and endocrinological literature.

The carcinogenic effect of estrogenic hormones in the development of abnormal growth, and the relationship of sex hormones to tumor formations, have been shown to be both actual

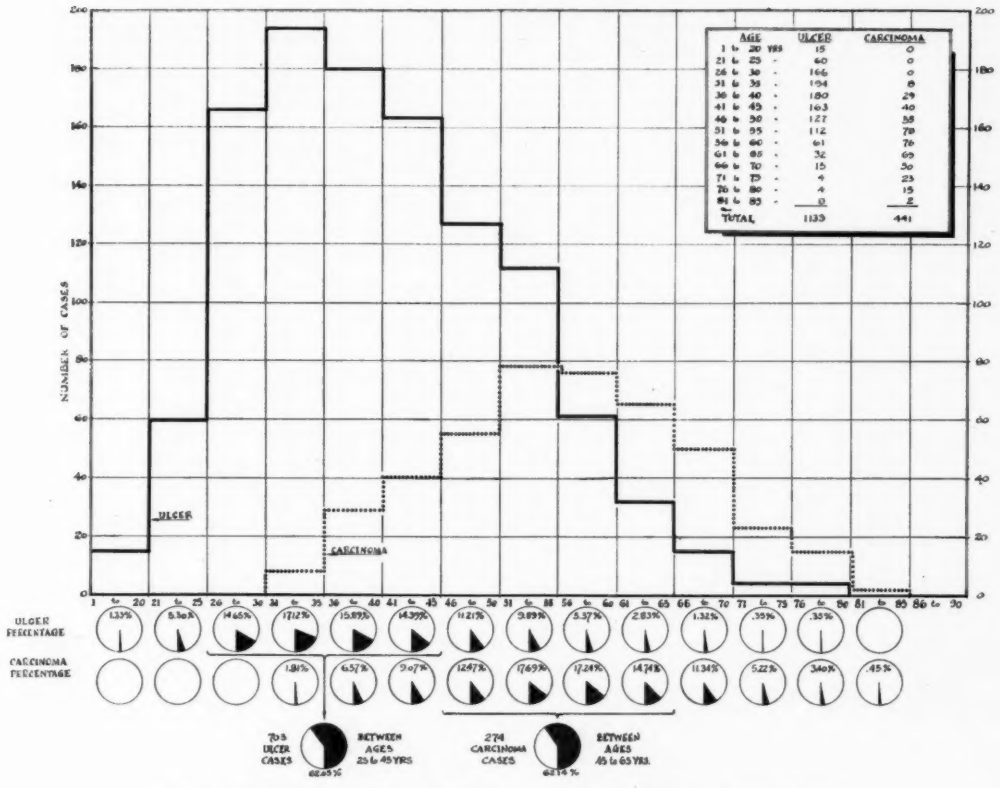
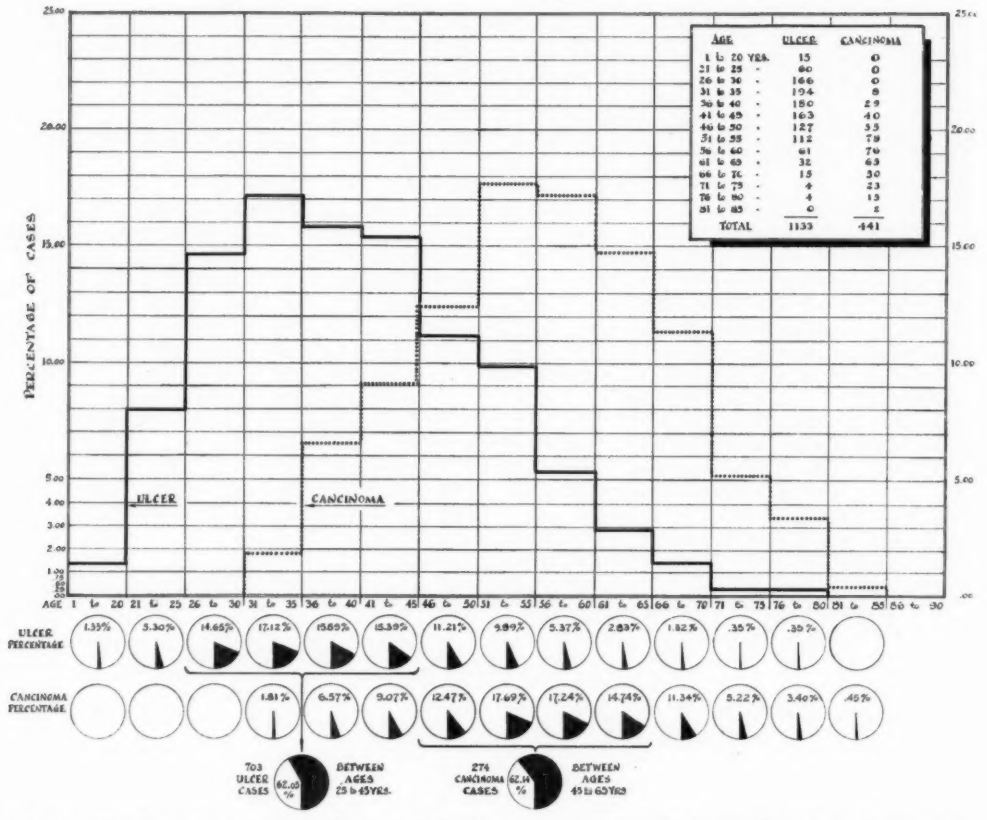

AGE
ULCER
CARCINOMA
1 to 20 YRS 15 0
21 to 25 " 60 0
26 to 30 " 166 0
31 to 35 " 194 8
36 to 40 " 180 29
41 to 45 " 163 40
46 to 50 " 127 58
51 to 55 " 112 78
56 to 60 " 61 76
61 to 65 " 32 69
66 to 70 " 15 50
71 to 75 " 4 23
76 to 80 " 4 15
81 to 85 " 0 5
TOTAL 1139 441
NUMBER OF CASES
ULCER
CARCINOMA
ULCER PERCENTAGE
CARCINOMA PERCENTAGE
703 ULCER CASES
BETWEEN AGES 25 to 45 YRS
274 CARCINOMA CASES
BETWEEN AGES 45 to 65 YRS.

Chart 4. Showing the difference in maximum ages in carcinoma and peptic ulcer.

and definite by repeated experiments. Several workers have recovered excess estrogens from the urine of carcinomatous individuals (Aron, Engel, Fiessinger and Moricard, and Saphir). In a review of this subject by Dodds the amount and character of the hormone is discussed and its possible use as a diagnostic and therapeutic aid pointed out. Belief that steroids closely related to androgens and estrogens play an active part in the heightened cellular activity of carcinoma and that their presence is a result of altered pathological anabolism, has been expressed by Murlin and associates, 55.

Experiments on the physical reactions of the carcinogenic hydrocarbons with sterols, other than sex hormones, which play an important rôle in human metabolism, have shown their modes of interchange. Interaction between polycyclic hydrocarbons and sterols and their structural relationship to carcinogenic agents and related substances normally present, into carcinogenic agents within the body has been stressed by Clowes, Davis and Krahl; Fieser; and Marker. While the carcinogenic activities of estrogens are supposedly exerted only on the secondary sex organs, Loeb allows that the carcinogenic hydrocarbons have much less specificity of action, and that they may transform any tissue into cancer tissue with which they have continued contact under proper conditions. Findings of increased amounts of normal and abnormal metabolites, compounds steroid in character, in the urine of patients with adrenal tumors and other carcinomas, indicate an



AGE	ULCER	CANCINOMA
1 to 20 YRS.	15	0
21 to 25 "	90	0
26 to 30 "	166	0
31 to 35 "	194	8
36 to 40 "	180	29
41 to 45 "	163	40
46 to 50 "	127	55
51 to 55 "	112	79
56 to 60 "	61	76
61 to 65 "	32	63
66 to 70 "	15	30
71 to 75 "	4	23
76 to 80 "	4	13
81 to 85 "	0	2
TOTAL	1133	441

Chart 5. Showing percentage age incidence of peptic ulcer compared with age incidence of gastric carcinoma cases.

increased or altered metabolism of normally occurring substance (Burrows, Cook et al; and Murlin, Kochakian, Spurr and Harvey, 55).

Patients with various carcinomas have been found to have a tremendous increase in their urine cholesterol output (Bruger, 12). It should be noted that the blood cholesterol, in those cases of carcinoma with increased cholesterolin-uria, is normal. The increased cholesterol is not associated with increased urine protein. Peculiarly, this finding is not present in epitheliomas of the skin, but most notably in visceral carcinoma. This condition is also found in approximately 1 per cent of supposedly normal people against approximately 95 per cent of carcinoma patients (Bruger, 13).

Experimental work with the injection of carcinogenic agents into various tissues has shown that tumors develop much more easily in some tissues than others. This finding is applicable to the gastrointestinal tract. A species difference has also been noted. Certain cells within the organism are more susceptible to neoplastic transformation than others under equal contact with carcinogenic agents. However, it has also been noted that the response of a given tissue to a carcinogenic agent is specific for both cell and type of carcinogenic agent, and has no relationship to spontaneous tumor formation. Rusch, Baumann and Maison injected the submucosal layers of the stomach of rats with benzpyrene in 3 cases and caused the formation of a myoma, spindle cell

sarcoma, and adenocarcinoma of the stomach. Similar injection in the duodenum did not cause tumor formation.

Stewart, although causing the formation of gastric adenocarcinoma in four mice by the injection of methylcholanthrene into the muscular tissues of the stomach wall, believes that the gastric mucosa is relatively resistant to the action of methylcholanthrene. In this connection, the work of Perry and Ginzton has importance, in that they seem to have broken down the resistance of the mouse stomach to malignancy by combining 1, 2, 5, 6 dibenzanthracene with theelin, thereby causing gastric malignancies which were not caused by the use of 1, 2, 5, 6, dibenzanthracene alone.

Studies of gastric carcinoma in two races living under the same conditions, viz., Malays and Chinese, have shown the incidence of gastric malignancy to be five times as common in Chinese as in Malays (Snijders and Straub). In an attempt to correlate this discrepancy with the etiology of gastric carcinoma, an accurate study on other racial differences in gastric pathology has been made (Bonne, Hartz, and associates, 10). Similar racial differences were noted in only 2 other pathological conditions; chronic atrophic gastritis and goblet cell metaplasia were more prevalent in Chinese. Both of these conditions are common as regressive changes and as potential precursors of carcinoma.

We believe our own statistical and clinical findings agree with animal experiments to indicate that sex hormones affect the gastric mucosa and consequently the incidence of tumor formation. Controversial findings by competent workers are reported, and both estrogens and androgens have been shown to have protective powers against tumors. Estrogens have been reported both as a carcinogenic substance and as an immunizing agent against tumor inoculation and metastases. It would seem that the disproportion between these two hormones and other hormones is of greater importance than the activity of either one. However, since it has been determined that hormone effects are the resultant of the algebraic sum of all the endocrine secretions, we believe that several other hormone effects are involved, namely pituitary, thyroid, and adrenal hormones. The tumor forming and the tumor protecting effects of androgens and estrogens are not specific direct effects but general and indirect.

The establishment of atrophic gastritis as a definite disease entity, usually starting at middle life, is a step toward the correlation of gastric physiology and tumor pathology (Schindler and Murphy, 64). The apparent hormone dysfunction concomitant with this condition and its rôle in the development of carcinoma lead to a new experimental and therapeutic approach to gastric malignancy (Abrahamson and Hinton, 1; Koch, 39; and Moersch). Loeb stated in 1935 that, although estrogens were highly carcinogenic substances, they were active only in those tissues in which they induced growth processes. In the past 5 years, additional experimental proof shows that several hormones, including, we believe, the estrogenic hormones, affect the gastric mucosa.

Hormone imbalance or "disbalance" takes place during that period in which neoplastic changes most often occur. Although we realize that there are still many unproved facts to be established, it would seem that this imbalance (a), together with carcinogenic agents normally present (b), plus other predisposing causes (c and d) result in neoplasm of the stomach.

We realize the experimental work mentioned is incomplete, and largely inconclusive. However, the problem of gastric carcinoma is of such tremendous proportions and importance, that we believe many experimental and clinical observations by various workers with sufficient material will be necessary to bring us to a correct conclusion.

SUMMARY

1. The clinical, surgical and experimental studies for the early diagnosis and therapy in gastric carcinoma have so far been largely unsuccessful.

2. Two established and unexplained facts are the age incidence and sex discrepancy.

3. The effects of vitamins upon the gastric mucosa as well as elsewhere, are partially due to their relationship with, and effect upon, endocrines.

4. Experimental work shows that the gastric mucosa can be influenced by hormone activity, including changes in the androgen-estrogen ratio.

5. The possibility of sterols, the sex hormones, and other hormones normally present in the human body being transformed into highly active carcinogenic agents, within the body, has been pointed out.

6. Experimental work has shown the relationship of sex hormones to carcinogenic substances and a possible mode of interchange from one to the other.

7. Changes in blood contents and activity of several hormones takes place at the time when gastric carcinoma most frequently occurs.

8. We have presented the conception that the gastric mucosa is a gland and, therefore, is liable to influence similar to those which control the functioning of other endocrine glands.

9. There are marked differences in blood hormone content between the sexes. Radical changes take place following involution. These differences help explain the sex discrepancy and age incidence in gastric carcinoma and benign gastroduodenal lesions.

10. We believe that the relationship between the sex hormone control of the gastric mucosa and gastric pathology including neoplasm, is an actual one, and that further clinical and experimental work along the principles outlined should be instituted to throw further light on the problems of etiology, diagnosis, and therapy of gastric carcinoma.

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SURGICAL TREATMENT OF PILONIDAL (DERMOID) CYSTS

A Study of 100 Consecutive Cases of Excision and Primary Closure

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THE subject of pilonidal (dermoid) cysts, with their preoperative preparation, operative treatment, and postoperative management, is a homely, but timely one. The true incidence of the disease in civil life is unknown. However, at the present time soldiers between the ages of 20 and 25 years are pouring into Army hospitals, requesting attention for infected and draining pilonidal cysts. The problems associated with the management of the lesion in civilian hospital practice are multiple and often aggravating. These same problems, arising in military hospitals coincident with the disease in men assigned to full military duty, become formidable.

The primary purpose of an Army General Hospital is the rehabilitation and return of soldiers to military duty as quickly as possible. There is little space available for prolonged hospitalization and no provision for extended convalescence. Therefore, many of the recognized operative procedures in the treatment of pilonidal cysts, such as excision and packing without closure, with its attendant delayed healing of from 2 to 6 months, must be supplanted. A perplexing complication in this problem, as far as the Army is concerned, is the fact that pilonidal cysts are considered to be congenital, to have existed prior to induction of the patient into the Army, and as such, any operative treatment is elective and not an emergency. Furthermore, the economic aspect of the problem must be considered and constantly borne in mind. Most of these soldiers are in the first important phases of their training, having been in the Army only 2 or 3 months. The trauma associated with military training probably activates a hitherto silent lesion, and some form of treatment must be given. Yet that treatment must not entail long and expensive hospitalization, thus depriving the Army and the country of the services of these soldiers.

There are many lesions the surgical treatment of which is elective and may be postponed. However, an infected, draining pilonidal cyst requires attention. Soldiers so afflicted cannot sit or lie down comfortably, cannot stand without frequent changes of dressing and linen, and experience a decided decline in their military efficiency. Conservative treatment results in improvement which is permanent only so long as no further trauma is encountered. From a military standpoint, these men are greatly handicapped until the lesion is removed.

In view of these facts, the lesion must be removed. But it must be done in such a way that the patient is quickly returned to duty, with a healed wound requiring no dressing or care, and with as little probability of recurrence of difficulty as possible. Therefore, primary healing of a clean surgical wound, following excision of the cyst, is necessary. A routine of preoperative and postoperative management, as well as surgical technique at the time of the excision—the complete excision of the cyst and the primary closure of the wound—has been followed at LaGarde General Hospital with excellent results.

During the 12 months from August 7, 1941, to August 1, 1942, 133 patients with pilonidal disease were operated upon at LaGarde General Hospital, New Orleans, Louisiana. This paper is based upon a study of the first 100 consecutive cases. The immediate progress of the 33 remaining patients will be discussed.

DEFINITION

A pilonidal cyst may be defined as an epithelium lined cavity containing hair fol-

From the Surgical Service, La Garde Hospital, New Orleans.
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licles, located in the midline, external or posterior to the sacrum and coccyx. Other terms have been applied to the lesion, most frequent of which are pilonidal sinus or fistula, sacrococcygeal dermoid or cyst, postanal dermoid or cyst. Single or multiple epithelium lined cutaneous sinuses may communicate with the cyst, usually opening externally in the midline, but often appearing on the gluteal surfaces at either side.

HISTORY AND ETIOLOGY

The condition was apparently first described by J. M. Warren in 1867. He thought it was due to a reversed or ingrowing hair follicle. Hodges probably first used the term pilonidal sinus in 1880, but credited Warren with the first description. Many other theories have been advanced. Mendelstadt (1885) thought the sinus might be derived from the lower end of the spinal cord. About the same time Lannelongue considered that the cyst developed from a process of ectodermal invagination, due to a faulty median skin agglutination of the sacrococcygeal region. More recently Stone suggests that it might be a vestigial structure analogous to the preen gland of birds.

There have been many explanations of the cause of this defect. The most logical is that which holds that the cyst develops as a result of an ectodermal maldevelopment in embryonic life. The cyst probably arises from a failure of complete separation of the primitive medullary canal from true skin. Gage (2) describes this maldevelopment in two ways. First, there is a congenital shortening of the caudal ligament which stretches between the skin and tip of the sacrum. This shortening causes invagination of the skin and, later, as the sacrum proceeds caudalward, a sacral dimple or sinus pointing toward the anus is formed. Second, there is a failure of complete fusion of the two neural folds, leaving a sac, or canal, at the lower end of the spine.

This second type is by far the most common. Gage (2) further divides it into three groups: (1) those confined to the sacrococcygeal region, lying upon and outside the lumbosacral fascia, without entering the sacral hiatus. These are most common. (2) Those cysts which enter the sacral hiatus but are not attached to the cord. (3) Those rare lesions which not only enter the sacral hiatus but are continuous with the spinal cord.

SYMPTOMS AND DIAGNOSIS

The objective findings and symptoms in the disease are so typical that they need little discussion. The true incidence of pilonidal disease is probably unknown, because the cysts when present are congenital and may lie dormant until trauma or undue strain causes drainage or infection. Swelling, pain, and tenderness in the midline, sacral region, should cause suspicion of the presence of a cyst. Often these signs of a low grade infection precede actual drainage. A chronic, dull, lower backache is often present. The recurrence of any of these symptoms, with or without the presence of actual drainage, is typical of pilonidal cyst.

Actual drainage of a thin, whitish material from a midline sinus is pathognomonic of the disease. There may be one or more such sinuses or dimples from which clumps of hair may protrude. Recurrent infection may have caused burrowing subepithelial sinuses and cavities with drainage to the outside through openings lying widely separated in the gluteal regions. Often such cavities and sinuses are so indurated that their course can be palpated. Eighty of these sinuses were draining at the time patients were admitted to hospital, and 20 patients were acutely infected with abscess formation.

Diagnosis should be simple. Tenderness and swelling, inflammation or frank infection in this area should suggest the presence of a pilonidal cyst. Midline openings are pathognomonic. Probes may be inserted in lateral sinuses and will be directed toward the midline. It is rarely necessary to resort to the injection of a radio-opaque substance to prove the presence of the cyst. Such procedure may infrequently be of aid in determining the extent of a lesion. Differential diagnosis is not perplexing. Anal fistulas, presacral dermoids, ischiorectal abscess, carbuncle of the buttocks, syphilis and osteomyelitis of the coccyx or sacrum, may all simulate pilonidal disease.

TREATMENT

Surgical treatment has offered the best chance of cure. Excision and packing, excision and primary closure, or some combination of these two methods have been most frequently used, depending upon the individual cases and their needs. Twill has suggested and used radiation therapy in a few cases with excellent results. Buie has used marsupialization of the cyst in selected cases and reports satisfactory results. The open method has been most popular, but since the advent of sulfonamides, the closed method has been frequently used.

Wide excision with open packing probably admits of the least chance of recurrence. Kleckner in a series of 4,231 cases reports 1.13 per cent recurrence. The average time of healing is not given, but the usual time in operations such as these is 2 to 6 months. Rogers reports 97 per cent successful excision, with average healing time of 9 weeks. Pickett and Beatty, working with 30 cases at the Station Hospital at Fort Sill, Oklahoma, recommend the open method and state the healing time as from 8 to 11 weeks.

General hospitals in the Army could not undertake the excision of pilonidal cysts at the rate of 130 and more a year, one every third day, if each case were to remain 2 or 3 months. Yet, excision and primary closure has carried a fearful incidence of infection and recurrence. Kleckner collected 365 cases and they show a recurrence of 23.29 per cent; Swinton and Hodge in 30 cases show 16.6 per cent recurrence. Gage (3) and Strug have each reported relatively large series of cases of excision and primary closure with no recurrences. Plastic types of operation, i.e., the Lahey lateral parallel incisions and the pedicle flap modification were not used in this series of 100 cases. Methods utilizing a combination of open and closed technique have not been uniformly successful.

PREOPERATIVE PREPARATION

Forty per cent of the cases in this series were infected at the time of admission, 20 per cent grossly so. Eighty cases were draining more or less profusely. All had some degree of soreness and drainage. The preoperative treatment is very important. Each patient was thoroughly shaved and cleansed on admission, and this shaving was repeated at least weekly during the hospitalization. Those lesions which were infected or draining were intensively compressed with hot saline packs until the evidence of infection disappeared. One or two courses of oral sulfathiazole were given to those grossly infected. A course of treatment was begun with 2 grams of the drug and continued with 1 gram every 6 hours for 3 days, a careful check of the urine and blood being made daily. The diet was not unusual. Mineral oil and milk of magnesia were used daily to insure free bowel movement. Ideally it would have been well to discharge these men with the gross infection as soon as it had resolved and to postpone operation for 2 to 6 months. Obviously this could not be done in the Army. As soon as the acute inflammation subsided, the drainage usually practically ceased. When the induration and tenderness disappeared, operation was performed on the average of about 1 week later.

Soap-suds enemas were given the night before operation as immediate preoperative measures. Nothing was allowed by mouth after 12 midnight, and seconal or nembutal was given the evening before operation as a soporific. Immediately before operation 1/150 grain atropine and ¼ grain morphine sulphate was given by hypodermic. The entire buttocks and lower back were shaved clean. Methylene blue or other such "chemical ferrets" were not injected into the sinuses previous to the actual operation. It has been found by Rogers and Hall that such dyes often permeate the walls of the cyst and diffuse through healthy tissue, thus necessitating the wider removal of tissue and sacrificing much healthy tissue. The less tissue removed, the less tension will be placed on the wound.

OPERATIVE PROCEDURE

All these patients were given a spinal anesthetic; usually about 75 milligrams of novocain crystals was used. The patient was placed prone upon the table, the pelvis elevated by lowering both head and feet and placing a medium sized sand bag beneath the pelvis. The entire operative area was cleansed thoroughly with soap and water, and a dry

sponge was partially inserted into the anus. The scrotum was protected and the area cleansed with ether. An important step in the operation was the placing of wide adhesive straps upon each buttock, about 4 inches on each side of the midline. The tails of these straps were pulled tightly beneath the operating table and fastened. Thus the buttocks were separated, and excellent exposure of the operative field under considerable tension was obtained.

Tincture of merthiolate was applied and the patient was draped, the last tincture of merthiolate sponge covering the rectal sponge. Each sinus and opening was carefully explored with a probe and every indurated tract outlined with the examining finger. The anal region should be carefully observed for possible openings. Methylene blue was injected under pressure into each sinus, and the surrounding tissue compressed forcibly to endeavor to force the dye into every tract.

Since it is extremely important that the skin edges perfectly unite during closure, the incision is started at the anal end of the tract, including the caudalmost sinus. With the scalpel point, the bottommost "V" of the incision is first made. A double elliptical shaped incision is finally obtained, enclosing an average cutaneous area of 5 centimeters by 2 to 3 centimeters. Dissection of the cyst itself is always begun caudally, dissecting from below upward. Often it is necessary to undermine the caudal skin margin, but this cavity may be closed later and is preferable to continuing the incision too close to the anal margin. Care must be taken to avoid injury to the rectum which lies in the bottom of the caudal portion of the wound. The dissection is carried down to the lumbosacral fascia in the midline and the gluteal fascia on both sides. Ordinarily this will include the entire tract. If the tract is entered, the incision is enlarged to contain it. Sinuses projecting laterally may be dissected through incisions perpendicular to the main elliptical incision. Care is taken not to injure the coccyx, and particular care is observed in avoiding laceration of the anal sphincter, with its spectre of fecal incontinence.

A cardinal point in the technique is careful and complete hemostasis. Fine catgut, plain No. 0 or No. 00, is used. The patient is asked to strain and cough several times to reveal concealed bleeding points. There should be no possibility of even a small postoperative hematoma. Single sutures of chromic No. 2 catgut are placed and held, but not tied, in the base of the wound in such fashion that, when tied, the gluteal fascia on each side will approximate the midline. With the placing of each of these sutures, small bits of the lumbosacral fascia are included to obliterate that dead space. The clamps holding these sutures are pulled upward out of the way. The lower angle of the wound is partially closed before the tension adhesive straps are cut. When the operation is rightly performed, the buttocks fall together, and the view of this angle is obscured. Plain No. 1 catgut is placed in the level above the chromic No. 2 to obliterate the space at the caudal angle. Usually one or two such sutures may be placed and tied before the tension is released. Two or three end-on mattress everting skin sutures are taken at the lower angle of the wound, with particular care that the opposing skin edges exactly approximate. If there is to be trouble with wound healing in the absence of infection, it will be at this angle, particularly if careful approximation is not obtained. Perspiration, tissue maceration, fecal material and dirt all may be present in this area to defeat healing. Sulfathiazole, or sulfanilamide crystals or powder are plentifully sprinkled in the wound, the adhesive tension strips are cut, and the sandbag is removed from beneath the pelvis. The wound usually falls together with no tension. The previously placed chromic sutures are tied and cut. The wound is closed in layers, No. 1 plain catgut and Davis No. 24 cotton being used. All dead space particularly must be obliterated, and the skin edges must be carefully approximated. More sulfathiazole powder is sprinkled plentifully in each layer of the wound.

If it has been necessary to excise laterally branching sinuses, these wounds are likewise carefully closed. Particularly careful hemostasis, avoidance of tension, and obliteration of dead space are all-important to the success or failure of the procedure. A pressure dressing is applied, held in place by wide adhesive

straps, which are so applied as to draw the buttocks even closer together and remove all possible tension from the wound.

POSTOPERATIVE TREATMENT

Almost equally important to the success of the operation, the postoperative management must be carefully planned. The patient remains in bed in any position comfortable to him, for at least 5 days, and longer in the case of obese patients, or those patients who have had previous excisions of the cyst. Liquid diet is allowed the first 24 hours, soft diet the next day or so, then a regular diet. No attempt is made to constipate the patient, but neither is he encouraged in any way to have a bowel movement. Most of the patients will have no urge for stool for 6 to 10 days. The first dressing is done the 8th day, at which time any sutures which are under tension are cut, and the sutures at the lower angle of the wound are removed. Dressings are done sooner, upon any indication, as continued fever, severe pain, or if a bowel movement occurs. In this latter event, the patient is carefully cleansed and a pressure dressing is reapplied.

An oil retention enema (100 c.c. olive oil) is given the evening of the 9th postoperative day, and a small soap-suds enema the morning of the 9th day after operation. Mineral oil, 1 to 2 ounces, is also started the evening of the 9th day. All sutures are removed on the 10th postoperative day.

Chemotherapy after operation is rarely used. In those cases in which a rather severe infection had been present before operation, and if inadvertently the cyst was entered at operation, prophylactic doses of sulfathiazole are given. There have been no untoward effects from the prolonged period of constipation after operation. There have been no fecal impactions. Likewise, there has been no separation of wounds through the strain of defecation too soon after operation, and the incidence of wound infection is greatly lessened.

RESULTS

One hundred and thirty-three patients were treated, as described, at LaGarde General Hospital. The first consecutive 100 were studied, since most of those patients have been discharged 6 months and more. As already stated, in 40 per cent of these cases there was some degree of infection on admission, and 80 were draining when first seen. Thirty-eight had had previous incision and drainage of the lesion, 10 had had more than one such temporary surgical relief. Ten per cent of these cases were recurrent pilonidal cysts, and according to the histories obtained from the patients, in 3 of these 10 recurrences patients had had the open type operation, the 7 remaining had been closed primarily. These histories are entirely unreliable, however, as far as the type of operation previously performed is concerned. Four of the patients had had more than one operation performed in an effort to eradicate the disease.

While the number of draining sinuses is no index to the severity of the lesion, it is interesting to note that over 90 per cent (92) of these patients had two or more patent sinuses. The average age of the patients was 23 years. There was one colored patient in the series. The average duration of symptoms was about 2½ years, but nearly one-third (31 per cent) had had no symptoms referable to the lesion until they had been inducted into the Army and were subjected to the trauma associated with military training.

Of the 100 cases under study, 98 were entirely successful. There were 2 patients who returned with typical recurrent pilonidal cysts. One had had a very large cyst necessitating a modified Lahey type of closure, and had been operated on once previous to the attempt at LaGarde General Hospital. The other demonstrated the necessity for scrutinizing carefully the midline approaching the anus. A small opening near the anus led directly into an epithelium lined sinus which in turn communicated with the recurrent cavity. Both these patients had had mild postoperative wound infections, the second undoubtedly because of the anal sinus.

The average time until complete healing in the usual, uncomplicated case is 14 days. These patients are dismissed to full duty on the 22d or 23d postoperative day, with well healed, soft wounds. The most usual com-

plication, and the one which causes the greatest delay in healing, is infection. There were five moderately severe and two severe wound infections. In all of these a large hematoma was first evacuated, demonstrating the need for meticulous hemostasis. Five definitely were closed with more than the usual amount of tension on the wound. Two of these patients had a mild diarrhea the 3d and 4th postoperative days, and it is conceivable that either the straining at defecation or soiling because of defecation contributed to the infection. Several mild infections of the "stitch-abscess" type were present, but cleared spontaneously.

The delay occasioned by these infections caused the average time of discharge to duty to be elevated to 28 days. Considering the series as a whole, these results are very encouraging. When it is further remembered that 72 of these cases returned to duty in about 3 weeks, the management suggested gains merit. Of the 72 cases remaining in the hospital 25 days or less, 5 cases had had recurrent lesions, and 20 had had previous incision and drainage of an acutely infected lesion. Of the 28 cases remaining hospitalized 25 days or more, 1 case had had multiple previous operations, 18 had had previous incision and drainage either once or more often.

Other postoperative complications were rare. Only one patient developed signs of renal insufficiency as evidenced by a relative anuria and multiple casts in the urine. Chemotherapy was stopped, fluids orally and parenterally forced, and the patient responded quickly.

EVALUATION

In the treatment of infected and draining pilonidal cysts in soldiers, the primary and most important objective is to excise the lesion surgically, and return the men to military duty as quickly as possible with a soft, healed wound. There is no single factor which contributes most to successful completion of this task. The entire rationale of treatment is important. The infected cysts must be treated conservatively until the acute inflammation has subsided.

In the operative treatment of these patients, the three cardinal principles of surgical procedure anywhere must be followed meticulously: (1) Hemostasis must be absolutely complete; (2) tension upon the wound edges must be at a minimum, and this is accomplished by adequate exposure and care to remove only as much tissue as absolutely necessary. It has been found that blocks of tissue 5 by 3 by 3 centimeters usually suffice to enclose the cyst entirely; (3) there must be no dead space remaining when the wound is properly closed.

Completely satisfactory eversion and approximation of the skin edges will aid greatly in complete healing of the wound. All such wounds are soft and nontender, and certain procedures recommended to forestall painful cicatrix are unnecessary. As in all surgical procedures adequate exposure is necessary, and the method suggested is satisfactory. The use of sulfonamide powders in the wound and orally, before and after operation, probably has been a great factor in reduction of the incidence of wound infection. Such infections, when developed, are best treated by adequate drainage and conservative treatment with daily hot sitz baths or compresses. The areas must be kept shaved completely.

Postoperative treatment is directed toward prevention of any undue tension upon the wound, and protection as carefully as possible against infection. Bowel movements are not encouraged until the 9th postoperative day, dressings are not changed unless necessary before the 7th postoperative day, and the wounds are never probed. The patients are kept in the hospital until their discharge and are not allowed the usual freedom of passes because of the possibility of traumatizing the wound inadvertently.

SUMMARY

1. One hundred consecutive cases of pilonidal disease in which patients were treated surgically by excision and primary closure were studied. Eighty per cent of the patients had draining sinuses upon admission. Ten patients had had previous operations, in which some type of excision had been done; 38 had had previous incision and drainage.

2. A program of preoperative treatment, surgical technique of excision with primary

closure, and postoperative management of pilonidal cysts in the Army Hospital has been described.

3. An incidence of recurrence of 2 per cent is reported. The wounds healed in an average of 21.5 days, the patients were returned to full military duty in an average of 28 days.

4. Seventy-two per cent of the patients had completely healed wounds in 14 days, and were hospitalized less than 25 days, returning to duty rehabilitated as useful soldiers.

5. Aside from the suggested preoperative and postoperative management, 5 factors are responsible for these results: (a) completely meticulous hemostasis; (b) avoidance of tension in closure; (c) obliteration of all dead space, knowledge of the anatomy of the region and care to avoid damage to the coccyx and anal sphincter; (d) the liberal use of chemotherapy, locally and generally; (e) careful approximation of wound depths and edges.

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THE SURGICAL TREATMENT OF INFANTILE HYDROCEPHALUS

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THERE is widespread pessimism in regard to the treatment of hydrocephalus. Thus Bucy remarks: "Except for cases that cure themselves, i.e., those that undergo spontaneous arrest, the outlook is almost hopeless. The majority die within the first four years of life, the first year claiming most of them .... At the present time, even the best-intentioned surgery can hardly serve other than to deny to some few cases the possibility of a spontaneous recovery by subjecting them to an operation and a surgical death."

So thoroughly convinced of the hopelessness of the situation are many physicians that cases of the relatively benign (Ingraham, 14), "external hydrocephalus" (subdural hygroma) go unrecognized for want of a puncture of the fontanelle, and any suggestion of increase of pressure of the spinal fluid is often considered a contraindication to operation on a meningocele (19). Yet by now, in a number of cases of hydrocephalus patients have been followed for years after successful operations of various types (Dandy, 4, 5; Putnam, 21, 22, 23; Scarff, 25, 26), and at least 2 series of cases are on record (23, 26) in which the operative mortality is low, and a large proportion of survivors are growing up in normal health.

The purpose of this paper is to describe the author's present technique, as it has evolved over 7 years, and to give a statistical report of his series, including a follow-up on some of the original cases (23). Recent reviews of the results of similar operations have been given by Scarff (26) and Dandy (5).

THE NATURE AND MECHANISM OF INFANTILE HYDROCEPHALUS

The term hydrocephalus is currently used to denote several distinct entities. A collection of fluid between dura and arachnoid is often referred to as an "external" hydrocephalus. In most instances, such fluid is high in protein and represents the residual of a subdural hematoma. An abnormal amount of subarachnoid fluid is sometimes spoken of as hydrocephalus; the collection is due to atrophy of the convolutions or irritation of the meninges. Atrophy of the brain as a whole gives rise to a dilatation of ventricles with normal intracranial pressure and has been called hydrocephalus. The use of the term "hydrocephalus" for these conditions is misleading, is not in accord with the classical description[1], and should be abandoned.

Entirely distinct from these entities, is the enlargement of the ventricles due to a chronic increase of pressure within them (23). The increase in pressure may in turn be due to any one of a variety of causes. It may result from an excessive secretion of fluid, from a papilloma of the choroid plexus, or from a hemangioma of the ventricular wall. Or it may result from a block of the aqueduct by an atresia, or of the fourth ventricle by means of a tumor. All of these sources of excessive pressure are rare in infants, and they will not be considered in this paper.

The common cause of chronic increased intracranial pressure is a peculiar congenital defect, of which the mechanism is still obscure. There is no reason to believe that the choroid plexus produces an excess of fluid in such cases, for the aqueduct may also be dilated. The foramina of Luschka and Magendie may or may not be atretic, or drawn down into the foramen magnum by an Arnold-Chiari deformity (3). There is some evidence that the

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[1]The condition of infantile hydrocephalus was doubtless known to the ancient Greeks. As far as I can find, it was not mentioned by Hippocrates, in spite of the reference to his works given by Richard Whytt, whose oft-cited description is overrated. The earliest description I have been able to find is that of Celsus, who says " .... *Ubi humor cutem inflat, eaque intumescit, et prementi digito cedit: ὑδροκέφαλον Graeci appellant.*" Apparently therefore, the earliest authors recognized abnormal pressure as the fundamental characteristic of the disorder.

arachnoid is obstructed about the cerebellum or over the convexity in many cases. There is a normal, or almost normal, transmission of dyes and of pressure relationships between ventricles and lumbar sac. Whatever the mechanism, the pressure is often elevated to a degree to endanger the brain—sometimes as high as 400 millimeters of water over long periods of time.

The obstruction to the flow of fluid is usually not the only abnormality present, however. It is often associated with a meningocele and may become manifest only when the sac is repaired. In such instances, the Arnold-Chiari malformation is usually present (24). There may be instead, or in addition, severe cortical aplasia, agyria, microgyria, absence of the corpus callosum, or a miscellany of other serious defects (22, 24).

INCIDENCE AND RESULTS OF HYDROCEPHALUS

According to Murphy, hydrocephalus alone or with spina bifida was reported in 88 living children among approximately 130,000 births. An even higher incidence has been reported by other observers (27). This figure obviously fails to include the surgically important cases which appear later in infancy or following operation on a meningocele — perhaps numbering as many again.

There are no statistics to show the mortality from hydrocephalus alone, or from associated deformities. The death rate is certainly high. Occasional infants are said to recover with nonoperative treatment and without damage to the brain. Thus, Penfield (19) states: "Postural dehydration is a method of treatment for mild cases . . . . For 10 years I have used this treatment for less severe cases . . . and I have seen many (perhaps 10 or 12) permanent cures, particularly in cases associated with spina bifida." This the author has never observed and no other statistics are available. The actual cases reported by Penfield are not particularly encouraging (20). It is possible that some of the cases to recover were instances of a temporary osmotic or inflammatory excess of choroid secretion.

Certain infants suffering from hydrocephalus survive to adult life although they cannot be said to recover. Most of them are feeble-minded, but in a few instances, normal mental development is attained in spite of gross enlargement of the head (23). It has been supposed that a mild hydrocephalus is favorable to outstanding mental development. A survey of the autopsy records of the distinguished men usually selected as examples (Cuvier, Helmholtz, Gauss, Menzel) lends no support to such an idea. It appears that none of them suffered from true hydrocephalus, as here defined.

DIAGNOSIS AND PROGNOSIS IN INDIVIDUAL CASES

The following outline of procedure is suggested on the basis of the author's experience. It has evolved gradually during the growth of the series of cases presented, but in general represents the routine usually followed for the cases in the "new series," which will be presented subsequently. Nothing is to be gained by any radical treatment of cases of hydrocephalus in which the head is enormous at birth, or other obvious external defects exist.

The symptoms which usually first give rise to a suspicion of the existence of hydrocephalus are a slight enlargement of the head or persistence of fullness of the fontanelle when the head is elevated. This may come on spontaneously at any time within 6 months after birth, or after operation for meningocele. The child becomes dull or fussy, feeds poorly, and may vomit. Two questions then present themselves. The first is, what is the origin of the increased intracranial pressure? The second is, what is the outlook for the child's mentality if the pressure is relieved?

The question as to the type of hydrocephalus present is ordinarily easily answered if the condition arose following an operation for meningocele. If it came on spontaneously, the problem is sometimes settled by an x-ray of the skull, which shows not only separation of sutures but also a fenestration of the bone in many cases of congenital hydrocephalus (Fig. 1).

Further information may be obtained by puncture through the anterior fontanelle. This should be performed with the patient in a recumbent position. If the baby is placid, ac-

curate pressure measurements may often be obtained without the use of an anesthetic; if there is any difficulty, however, the subcutaneous administration of evipal or pentothal is advisable. The normal infant should have an intracranial pressure of 50 to 80 millimeters of water (measured from the scalp). If the pressure is normal or nearly so, operation may be safely postponed.

Aside from measurement of pressure, it is of great importance to measure exactly the depth at which fluid is obtained. The scalp and skull are less than 0.5 centimeter in thickness. If fluid is obtained at this depth, it is probably subdural in origin. Arachnoid fluid is practically never obtained. The depth beyond the dura is a measure of the thickness of the ventricular wall, which is naturally of prognostic importance.

The fluid should be examined for cells, and a determination of protein, sugar, and gold sol should always be made. Meningitis in infants —apparently especially in premature infants —may exist with relatively little effect on the general condition or temperature, and is easily mistaken for congenital hydrocephalus. The presence of blood or a xanthochromic fluid or a protein content of 100 milligrams or more, usually means a subdural hygroma. The recognition and treatment of this common condition is extremely important (14), but it will not be considered further here.

Usually no other special examinations are needed for diagnosis. Ventriculography in hydrocephalic infants carries such a high mortality—almost half that of endoscopy—that it should be avoided if possible. In puzzling cases it may be of great value, and by its use Scarff (26) has been able to demonstrate a growth in thickness of the cortex after operation. Injection of dye into the ventricles is seldom of decisive value. If the results of other examinations are inconclusive or apparently contradictory, one or the other of these procedures may be carried out, but they are seldom essential.

In cases of atresia of the aqueduct, hydrocephalus is usually either present at birth, or develops suddenly with high pressure. Obstruction of the fourth ventricle by tumor also produces an acute hydrocephalus, but seldom early in infancy. If either is suspected, simultaneous ventricular and lumbar puncture should be performed (under a soporific), and the degree of dynamic block demonstrated. Comparison of the protein content of the fluid in the two ventricles and in the lumbar sac is also sometimes helpful in diagnosis. In case there is still doubt, air may be injected into the ventricles.

Quite as important as the neurological diagnosis is an estimate of the infant's mental activity. Hydrocephalic babies who feed poorly, take no interest in their surroundings, and do not cry or respond, are presumably the victims of extensive cerebral defects or irreversible damage to the brain, and should seldom be operated upon. They practically always die whether the pressure is relieved or not. If there is any question whether the symptoms are due to pressure alone, daily ventricular punctures may be done to see if improvement occurs.

More difficult is to judge how near normal a somewhat responsive child is. The mother's estimate is rarely to be trusted. An experienced psychometrist or child psychologist is often of great help in deciding. If none is available, a careful inventory should be made of all the child's activities—reaching for objects, fixing and co-ordinating the eyes, evidence of recognition of mother or nurse, spitting unpleasant objects (paper soaked in vinegar) out of the mouth, repeating syllables.

There are several brief texts which describe tests suitable for determining the degree of development of young infants. The *Iowa test scale for young infants* (13) is inexpensive and easily obtainable. A more extensive treatise is *Testing Children's Development from Birth to School Age* by Buehler and Hetzer. The tests described by Kuhlmann are simple and reasonably reliable.

While the surgeon should always insist on a psychometric examination being carried out, for his own protection, it must be admitted that circumstances often arise which make it difficult for him to refuse operation, even when the mentality is questionable. He should, however, at least give the patients and the referring physician due warning that the prognosis is poor.

NONOPERATIVE TREATMENT OF HYDROCEPHALUS

Several nonoperative forms of treatment have been suggested: the administration of diuretics (16), irradiation of the choroid (28), and postural drainage, keeping the infant propped in a sitting position (19). Statistically valid series of case reports, giving pressures or head measurements before and after such forms of treatment, have not been published. In favorable cases, in which the infant's mental activity approaches the normal and there are no definite contraindications to operation, conservative methods of treatment should not be used for more than 2 or 3 weeks if the intracranial pressure is above 150. If it is above 300, a moderate emergency exists, and operation should be undertaken at once.

DESTRUCTION OF THE CHOROID PLEXUS IN THE TREATMENT OF HYDROCEPHALUS

This is the only form of treatment which will be considered here. The papers of Davidoff and D'Errico discuss the other types.

Endoscopic coagulation of the choroid plexuses was first successfully carried out by Lespinasse in 1910, by means of an operating cystoscope, according to Davis. It has been sporadically utilized since. The whole subject was put on a sound physiological basis for the first time by Dandy and Blackfan in 1918 (8). Dandy later (6, 7) proposed destruction of the choroid plexus by an open operation, the present form of which was first announced in 1922. The procedure consists of inserting a speculum (Kelly cystoscope) through the cortex, emptying the ventricle, and removing the choroid after clipping its ends. Both sides are done at one sitting.

Stimulated by Dandy's work, and by the use of an endoscope for viewing the anterior of the ventricle by Fay and Grant and by Mixter in 1921, Scarff (25) and the author (21) almost simultaneously, but independently, designed special endoscopic instruments for the coagulation of the choroid plexus.

TECHNIQUE OF ENDOSCOPIC COAGULATION OF THE PLEXUS

The glass bipolar ventriculoscope is recommended for the following reasons. There is practically no space wasted in the cross-section; all of it except the electrodes is devoted to the transmission of the image. This large "optical aperture" permits far clearer vision in a cloudy medium than do instruments of the cystoscope type. The diameter of the instrument is smaller than that of any other operating endoscope. It has a deep focus; structures in the ventricle may be seen at a distance of several centimeters, or in direct apposition. Nothing projects outside of the field of vision. Most important of all, the current passes only between two closely-placed electrodes, actually in the field of vision, and is therefore confined to structures floating in the fluid. When unipolar coagulation is used, the current necessarily passes through the basal nuclei, often producing softenings (22).

The glass ventriculoscope has certain disadvantages. There is some difficulty in obtaining proper glass and in grinding it to exactly the correct form. Some of the earlier instruments especially were unsatisfactory in one or the other respect. It is fragile. The front surface is easily scratched or pitted by permitting sparks to pass between the electrodes through the air. The electrodes are easily torn out. The instrument cannot be boiled or autoclaved, but must be sterilized by immersion in 70 per cent alcohol.

TECHNIQUE OF OPERATION

Inhalation anesthetics are to be avoided. Tribromethanol by rectum, sodium pentobarbital by mouth, or one of the soluble barbiturates subcutaneously are satisfactory. Anesthesia may be supplemented by minute doses of morphine.

When the infant is immobilized, the entire head is shaved. (This is a favorable opportunity to take a photograph.) The patient is placed on an elbow-high table, with a folded blanket under the right hip and shoulder, and the head turned as far to the left as it will go. The head is elevated on sandbags, and kept in this rotated position so that the site of proposed incision is approximately uppermost (Fig. 2). A scrub with alcohol followed by bichloride is an efficient preparation.

The incision should be a curved one, about 5 centimeters long, to give access to a spot 3

centimeters from midline in the parieto-occipital region, well away from the motor cortex. The skin is infiltrated with procaine, and the area of incision outlined with a scalpel. Draperies are applied—a mastoid sheet is excellent for the purpose. The incision is then carried cleanly through skin and periosteum in one sweep. Few hemostats are required to check bleeding. A self-retaining retractor is inserted.

The bone is perforated with a hand-drill or a small periosteal elevator. It is removed to expose an oval area of cortex about 2 by 3 centimeters in size. Before the dura is opened, the pressure in the ventricle should be measured by means of a manometer attached to a needle, if this has not already been done. The dura is then opened by a straight incision, and any large vessels in the underlying pia are clipped or stitched to it. An incision about 2 centimeters long is made through the pia, and extended into the ventricle with the handle of a scalpel.

At this point, the operator puts on a sterile celluloid mask, extending over the mouth and nose, which might occasionally touch the top of the instrument. The operating room is completely darkened. The instrument, with wires attached to the lamp battery and to the diathermy apparatus, is carefully inspected to make sure that both ends are clean. The lamp carrier is retracted within the instrument, which is then plunged into the ventricle. As soon as the tip is in fluid, the lamp carrier is cautiously pushed forward until adequate illumination is secured.

The difficult part of the operation consists in locating and destroying the plexus without injuring the walls of the ventricle. This is accomplished by moving very slowly down the septum pellucidum, and following a vein from its smaller tributaries to its termination adjacent to the plexus. The instrument should be rotated so as to keep the point of the lamp away from the wall. When the fluffy pink plexus is encountered, the tip of the instrument is placed directly upon it. A coagulating current, barely strong enough to cause a change of color of the tissues and never permitted to spark, is passed for about a second for each area touched. The plexus is followed first on its lateral surface, well into the anterior horn, over the glomus, and as far as possible into the temporal horn. Particular care should be taken to move the glomus about and turn it over, for it often lies in folds.

During the course of coagulation, the front surface of the instrument tends to become covered with precipitate, and it must often be removed for cleaning. Relatively little bleeding may seriously obscure visibility, which, however, usually improves as time goes on. Some of the blood may be washed out by syringing with large volumes of Ringer's solution. Bleeding points should be sought and coagulated thoroughly. Care should be taken not to get air into the ventricle or under the dura. It should also be remembered that any bubbles given off during coagulation are a mixture of hydrogen and oxygen, and therefore explosive.

Sometimes there is a perforation of the septum, and it is possible to reach the contralateral choroid plexus. Usually, however, it is best to content oneself with a thorough destruction of one side at a sitting, as this is less of a strain on the patient than a bilateral operation.

When the plexus is thoroughly coagulated—which ordinarily takes 20 to 50 minutes—the instrument is withdrawn. The dura is carefully sutured. It is desirable to sew the periosteum in the layer of sutures in the galea. The skin is closed separately. A small collodion or latex cocoon is the only dressing required.

A transfusion or infusion is desirable, and the child can then be returned to its usual schedule as soon as it recovers from the anesthetic.

No particular after-care is needed. Feeding may be difficult for a few days. If the fontanelle remains tense, it may be punctured to remove fluid, which is then usually found blood-stained. As soon as the fluid becomes clear, or within 2 weeks, the advisability of operating on the opposite side may be considered. If there is any real doubt about it, reoperation is best postponed until it becomes clearly necessary.

Occasionally reoperation also fails to give adequate relief. If this occurs, the first operative wound or both should be re-opened and the plexuses inspected to see if any tags of secreting tissue are left behind.

TABLE I.—INFANTILE HYDROCEPHALUS, TREATED BY ENDOSCOPIC COAGULATION OF THE CHOROID PLEXUSES

	Old series 1934	New series 1935-1942
Patients	17	25
Operations	36	35
Hospital deaths	7	4
Later deaths	8	7
Survivors	2	14

RESULTS OF TREATMENT OF INFANTILE HYDROCEPHALUS BY ENDOSCOPIC COAGULATION OF THE CHOROID PLEXUSES

One of the two patients operated upon by Lespinasse survived the operation and lived 5 years, according to Davis.

It is a pity that Dandy's cases have not been reported in detail. Although his method differs fundamentally from the one outlined here, inasmuch as a large opening is made in the brain and the ventricular fluid is removed, his statistics would be of great interest. Writing in 1932, he states: "Although the author has suggested removal of the choroid plexus from both lateral ventricles for this type of hydrocephalus, the survival period has not been long enough to be certain of cures" (4).

In a later article (1938), Dandy states: "I have had several undoubted cures resulting from this method," and reports 2 cases (5). He suggests that removal of the choroid plexus in the fourth ventricle be carried out if removal of the glomus is insufficient. As a last resort, he suggests resecting the plexus in the body of each lateral ventricle—a procedure which is usually carried out routinely as a part of endoscopic coagulation.

Scarff's results have been recently presented in detail (26). He has performed 48 operations on 20 patients, with 3 "operative" deaths. In 7 other cases, the symptoms were not relieved, and the patients died within a few months.

Of the survivors of the operation, 1 died of pneumonia 5 years after the operation. In another, the pressure has not been satisfactorily relieved. Four of the survivors are apparently normal mentally, according to careful psychometric tests. The interval since operation in the group of normal cases has been 8 months to 4 years. Of particular interest is the fact that Scarff was able to demonstrate an actual increase in the thickness of the ventricular wall after operation, by a comparison of preoperative and postoperative encephalograms.

RESULTS IN THE AUTHOR'S CASES

The author's cases of infantile hydrocephalus have been arbitrarily divided into two groups. The first series includes all of the patients operated upon during the developmental period of the operation, at the Children's Hospital, Boston. During this period, cases were taken without selection, and many were included in which such conditions as leaking meningoceles, gross abnormalities of the brain, prematurity, etc., complicated the picture of increased intraventricular pressure. Certain rules of thumb, embodied in the directions for study and operation which have just been given, were derived from these experiences and have undergone slight evolution since. The second series includes all of the patients subsequently operated upon (chiefly at the Boston City Hospital and the Neurological Institute of New York).

The statistics of the "first series" and "second series" are shown in Table I. There have been only 2 "hospital" deaths among cases of infantile hydrocephalus treated by endoscopic coagulation in the last 6 years. (A case of meningocele, and a case in which death occurred during subdural insufflation of air before operation, are not included.) In all of the patients operated upon, there has been an obvious decrease in intracranial pressure.

There is an interesting correlation between mortality and mentality. Of 10 patients with apparently normal mentality before operation, there are 4 survivors after intervals of 5 to 7 years. In this group 1 death obviously resulted from operation, another was due to recurrence after a unilateral operation, and the remainder resulted from causes apparently unrelated to the condition.

In contrast, of 20 patients known to have defective intelligence before operation, 17 are known to have died, in spite of the fact that the abnormal intracranial pressure was partially or wholly relieved by operation. The enlargement of the head existed at birth in 2 of these cases. This probably constituted a contraindication to operation.

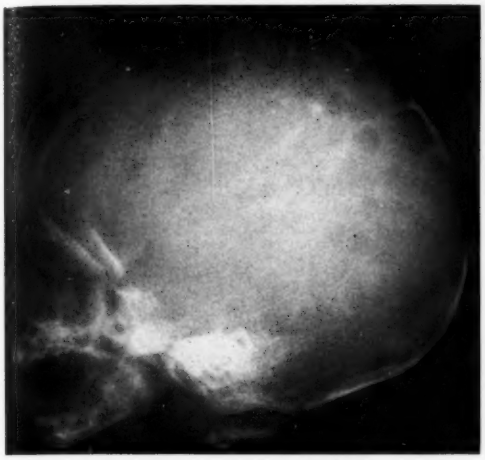

Fig. 1. Roentgenogram of skull of hydrocephalic infant, showing fenestration typical of "idiopathic," communicating hydrocephalus. (Courtesy of Dr. Cornelius Dyke).

Coagulation of the choroid plexuses has also been performed for the treatment of other conditions. In 6 cases, a large, sessile, ordinarily inoperable meningocele was brought to a manageable condition, but 5 of the infants died.[1] In 3 cases, the hydrocephalus resulted from a meningitis. All 3 died. Scarff (26), however, has had some successes in postmeningitic cases.

DANGERS OF THE OPERATION

The actual operative procedure carries surprisingly little risk. Collapse on the operating table has not occurred in the course of the second series. There has been only 1 death apparently due to hemorrhage or local damage to the brain in the recent series. Practically all of the other deaths in the new series have been due to digestive difficulties and respiratory infections, which are certainly often precipitated by the procedure. On the whole, the coagulation of the plexuses is about as well tolerated as is injection of air into the ventricles in comparable cases. Since the causes of death in individual cases have already been reported in previous communications (21, 22), and also by Scarff (26), a further discussion of them, therefore, appears to be superfluous.

[1] In 2 of the fatal cases, death seemed to be unrelated to the operation. A further analysis of this group is in preparation.

Fig. 2. Arrangement of sandbags to secure the proper position of the patient on the operating table, with the operative field uppermost.

FAVORABLE RESULTS

These can best be analyzed on the basis of a later follow-up report of the patients who were apparently normal at the time of operation. The last report on this group of cases was published in 1938 (23), and the case reports are numbered to correspond.

CASE 1. Dorothy M. was apparently normal at birth except for a small meningocele in the lumbar region. She was operated upon, and the meningocele was repaired. The operation left her with a flaccidity of the right leg. When she was seen at the Children's Hospital, Boston, on May 14, 1934, at the age of 6 months, the head had reached a diameter of 20 inches (50.8 cm.) and the fontanelles were bulging (Fig. 3). The pressure recurred rapidly after ventricular puncture.

She was operated upon at the Children's Hospital on May 18, 1934. Coagulation of the right choroid plexus was carried out without incident, and the patient made a rapid recovery. The excessive intracranial pressure was at once relieved, judging by the fontanelles, and the size of the head returned to normal.

The patient has been seen from time to time since. She was sent to a home for crippled children, where a brace was fitted to the paralyzed leg.

The patient had a convulsion in December, 1939, and was transferred to the Monson State Hospital. Dr. L. J. Robinson of the Hospital Staff kindly replied to a letter of inquiry as follows: "Since her admission here, she has had but one seizure and that a petit mal . . . She has shown no evidence of increased intracranial pressure, although she has vomited on an average of twice a month without known cause. Her mental examination of December 6, 1939 revealed a chronological age of 6–1, mental age 5–2, intelligence quotient 84. As you know, she has a flaccid paralysis of the lower right extremity . . . She is now home on a visit."

Fig. 3. Case 1, Dorothy M., before operation in June, 1934 (left), and in June, 1941 (right.)

Dorothy's mother writes as follows (June 14, 1941): "I am enclosing several snapshots taken during the past 2 weeks (Fig. 3). You will readily note the improvement in her since last you saw her. She is healthy and strong and is very much overweight for a child her age. Her shoulder and chest development are much in evidence due, no doubt, to the use of her crutches. She is very bright, memorizing what is taught her without effort, and has a wonderful memory. When playing alone, I sometimes hear her singing songs that she has learned one or two years ago . . . She is a hearty eater, and digests her food easily."

Fig. 4. Case 3, Daniel S., before operation in September, 1934 (left), and in December, 1940 (right).

CASE 2. This case was reported in full in a previous communication. In brief, J. F. an infant of apparently normal intelligence began to develop signs of increased intracranial pressure at the age of 1 week. The enlargement of the head was progressive in spite of repeated ventricular punctures. At the time of operation (May 12, 1934) the head measured 16 inches (40.7 cm.) in circumference, at the age of 4 weeks. The right choroid plexus was destroyed. The intracranial pressure was temporarily relieved, and following operation the patient became bright and alert.

There was a recurrence of increased pressure, at a time when I was out of town. A ventricular puncture was performed, and this led to intraventricular hemorrhage and death.

CASE 3. Daniel S. was born July 9, 1934, of healthy parents. He had a small meningocele high in the cervical region, which grew rapidly so that plastic repair had to be carried out July 25 to prevent rupture. After the operation, the head increased rapidly in size, in spite of repeated lumbar punctures. The circumference which was 14¼ inches (36.2 cm.) on July 25, increased to 16¼ inches (41.3 cm.) on September 8. The fontanelle was tight, and there seemed to be no justification for waiting for further progress (Fig. 4).

Fig. 5. Case 4., Gail H., before operation, in September, 1935 (left), and in January, 1941 (right).

Coagulation of the right choroid plexus was carried out on September 10, 1934, at the Boston City Hospital. There was an immediate decrease in the size of the head, to 16 inches (40.6 cm.).

The patient has been seen from time to time since. At the age of 3 years, he passed all of the Kuhlmann tests for his age, with the exception of those for co-ordination.

As of December 20, 1940, his mother writes: "Daniel is very well and is doing well in the first grade I had a talk with his teacher who says he is very smart in his school work. Last week I took him to see Santa. I wish you could of been there to hear him talk up and tell just what he wanted for Christmas. For a child of his age, he sure can get some funny sayings out of him." Figure 4 shows the patient at this time.

CASE 4. Gail H., a girl referred by Dr. Charles McCann of Brockton, Massachusetts, was born by instrumental delivery after 56 hours of labor. A definite enlargement of the head was first noticed at the age of 6 weeks. When first seen at the Boston City Hospital on September 16, 1935 (age 2 months) the head measured 17½ inches (44.5 cm.) in circumference, and the anterior fontanelle was bulging. A week later, the head measured 18¼ inches (46.4 cm.) and the child was distinctly more listless than before, (Figure 5).

On examination, a drooping of both eyelids was observed. Aside from this, and the enlargement of the head, no abnormalities were made out. The baby appeared rather inactive. She responded to loud sounds but did not follow objects with the eyes, or reach for them.

Coagulation of the right choroid plexus was carried out on September 23, 1935. The pressure measured 320 millimeters of spinal fluid with the head elevated, the patient being under pentobarbital sodium anesthesia. A second operation had to be carried out on the other side, on October 22, 1935.

At 18 months, she passed all of the Kuhlmann tests for her age, and some of those for 2 years.

In January, 1941, her mother reports as follows: "Gail is the youngest of a class of 15, but she holds her own with the best of them. Her arithmetic and spelling are exceptionally good. She was a little slow

Fig. 6. Case 5, Peter R., in May, 1939, 2 years after operation and shortly before death.

Fig. 7. Case 6, James E., before operation in 1937 (left) and about January, 1941.

getting started in reading. The teacher is very pleased with her progress and thinks she will make the second grade in public school next September." A photograph taken about this time is shown in Figure 5.

CASE 5. Peter R. was born June 5, 1936, with a large meningocele of the lumbar region, which was operated upon in another city when he was a few days old. Following the operation, there was some weakness of the sphincters and of the legs, which slowly improved. The head became definitely enlarged at the age of 3 weeks. At the age of 11 months, it became definite and progressive.

He was brought to the Boston City Hospital on April 27, 1937. At that time the head measured 20 inches (50.8 cm.) in circumference.

On April 28, 1937, the patient was operated upon. The pressure was measured at 290 millimeters of spinal fluid, calculated from the tip of the needle, with the head elevated on a pillow. A second operation was carried out May 13 on the other side. The head decreased slightly in size, and the patient appeared distinctly more bright. Details of the examination and photographs are given in the previous communication (23).

The baby returned to his home in the tropics, and did well at first. On May 6, 1938 his head measured 21½ inches (54.6 cm.) and the strength of his legs improved. A photograph taken May 3, 1939, is shown in Figure 6. In spite of this apparent progress, he had a convulsion and died on May 6, 1939.

CASE 6. James E. was born on July 17, 1937, at 7½ months. He was otherwise well, until about the age of 3 months, when the family physician, Dr. Thomas Shea of Holyoke, Massachusetts, noticed that the head was enlarging. The baby was seen by Dr. Jerome Whitney of Springfield, who recommended his admission to the Boston City Hospital for operation. Measurements of the head were as follows: August 17, 46 cm. (18⅛ inches); September 27, 47 cm. (18½ inches); October 10, 49 cm. (19¼ inches). The proportionate enlargement of the head was obvious (Fig. 7), the scalp veins were dilated, and the fontanelles were bulging. There were no obvious neurologic abnormalities, and the infant was able to carry out the normal performances for his age.

He was operated upon for the first time on October 13, 1937, under nembutal anesthesia. The pressure was measured at 300 millimeters of spinal fluid, from the tip of the needle with the head raised. The cortex was about 1 centimeter thick. The right choroid plexus was thoroughly cauterized. There were no postoperative complications, but within a week, it was obvious that the pressure had not been completely relieved. Accordingly the *left* choroid plexus was coagulated on October 25, 1937. At this time the pressure was measured at 200 millimeters of spinal fluid.

The patient was very little disturbed by the second operation, his head decreased in size, and he appeared distinctly more alert. He was discharged and did well for 2 months. At the end of that time, the parents observed that the head was growing larger again.

Accordingly, the site of operation on the right was re-explored on December 7, 1937. Under the dura lay a pool of dark yellow fluid, at a pressure of about 25 millimeters of water. This fluid contained 1200 milligrams of protein, and about 250 cubic centimeters of it drained away. The wound was closed tightly. During the following 2 weeks, the subdural space was punctured and drained every other day. Decreasing amounts of fluid were withdrawn, and finally toward the end of December no more accumulated.

The patient made good progress on the whole during the next 2 years. He grew normally, although the head was evidently slightly larger than the aver-

age. He appeared bright and alert, but was slow in learning to walk.

In November, 1939, he became restless and slept poorly. The head seemed to be growing again—measuring 23 inches (58.5 cm.) on December 24, 1939. At the request of Dr. Edward Bagg of Holyoke, he was admitted to the Neurological Institute of New York for study, on January 8, 1940. At this time, the circumference of the head was 60 cm. (23⅝ inches). There was a slight tenseness of the veins of the scalp. The patient showed a static ataxia, but neurologic examinations otherwise not remarkable.

A complete psychometric examination was performed by Miss Marion Corwin. Her summary is as follows: "Tests on this child are unsatisfactory because of his physical handicaps. He shows very poor motor co-ordination. Apparently a visual defect interferes with his response to pictorial material, but an occasional response suggests good grasp of that which he does see. His use of language might suggest an acceleration in development, but one rather imagines that because the child's possible activities are so limited, he has found conversation with adults especially stimulating and thus has achieved a greater development in this field than he would have achieved if he had more outlets. A single score has little value in a child whose development is so uneven, but one has the impression that he is correctly placed in the average group."

In addition, a ventriculogram was performed, which showed a moderate enlargement of the ventricles, a suggestion of block at the fourth ventricle (Fig. 8). The pressure, however, appeared to be within normal limits. The patient was discharged without treatment.

Since that time, he has done well. In January 1941 (age of patient, 3½ years), his mother reported by letter as follows: "His step appears very wobbly and uncertain and the slightest thing will throw him and he loses his balance temporarily for no apparent reason, grabs and holds and refuses to go on without assistance. Some days he does much better than others. His head measures 58½ cm., although his hair at present is very thick, height 40 inches, weight 42 lbs. In his wagon, he will put his groceries, pull them around, ask me, 'What I want today?' I'll tell him and he'll pick out just what I asked for and keep on going and if a neighbor passes by, he'll ask them also (this is on the porch), he knows everyone by name and can he ask questions. He is very good all day and while I'm busy working, he is in his play pen amusing himself wholeheartedly, providing I am not in the kitchen, if I am he wants to help me do whatever I'm doing, mashing potatoes, drying the dishes, straining orange juice, etc."

A photograph taken about this time is shown in Figure 7.

The statistics and case reports speak for themselves. It now seems well established that coagulation of the choroid plexus regularly reduces the intracranial pressure, and

Fig. 8. Encephalogram of James E., made in January, 1940.

that the relief is sufficient in most cases of infantile hydrocephalus to prevent death from pressure. Further, it seems clear that those patients who show a reasonably normal mentality at the time of operation usually make a good operative recovery, and have an excellent chance of growing up normally. To explain the results as due to a coincidental spontaneous recovery is to overlook three important facts: first, that the intracranial pressure was progressive before operation, obviously endangering the infant's brain, in all the cases here reported; second, that the intracranial pressure was decreased by the operation not only in these, but in all patients operated upon by the endoscopic technique; third, that the proportion of recovery from hydrocephalus was higher, both in this series and in that of Scarff (26), than has ever been reported in untreated cases.

SUMMARY

1. The present technique of endoscopic coagulation of the choroid plexuses in the treatment of infantile hydrocephalus is described.

2. A history of the operation as carried out by others, and of its theoretical background is presented.

3. The results of the operation are analyzed statistically, and a group of favorable cases is presented.

4. It appears that only infants with approximately normal mentality are likely to survive the operation.

5. In view of the fact that the operative mortality is now low, and that patients who can be shown to have normal mentality usually do well after operation, the conclusion seems justified that coagulation of the choroid plexuses should be tried in all cases of infantile hydrocephalus in which a reasonably normal intelligence can be demonstrated, unless other complications exist.

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NONTUBERCULOUS EMPYEMA THORACIS IN CHILDREN

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IN a previous communication (1) the value of fluoroscopic examination as a method for determining the proper time for rib resection in empyema thoracis was discussed. This method has become increasingly valuable since the advent of the sulfonamide drugs in the treatment of pneumonia. It is valuable not only as a guide to treatment but also as a means of accurate diagnosis.

INCIDENCE OF THE DISEASE

From January, 1936, to June, 1942, a total of 184 patients of empyema thoracis has been admitted to the Riley Hospital. In 1936 there were 45 cases; in 1937, 35; in 1938, 28; in 1939, 22; in 1940, 12; in 1941, 25; and for the first 6 months of 1942 there were 17 cases. Sulfonamide drugs were not used in any cases in 1936 and 1937. Since 1938 their use has greatly increased until in 1941 and 1942 practically all patients received these drugs. Although some observers (2) believe that the incidence of empyema has decreased with the use of sulfonamides, our study seems to indicate that this complication varies in number and severity from year to year and as yet has been uninfluenced by these drugs.

Our survey does show as pointed out by others (2, 4) that empyema occurs in a masked and often bizarre form more frequently since the use of the sulfonamides. This is evidenced by the fact that in 1936 and 1937, 93 per cent were general and 7 per cent were interlobar or encapsulated, and 1 per cent were bilateral. In 1941 and 1942, 75 per cent were general, 25 per cent were of the latter type, and 1 per cent were bilateral (Fig. 6).

TYPES OF ORGANISMS

The type of organism causing empyema varies from year to year. In 1936 the following varieties of bacteria were responsible—streptococcus, 5; hemolytic streptococcus, 3; pneumococcus, 35; gram positive bacilli and streptococcus, 1; no growth, 1. In 1941 there were: Staphylococcus aureus, 2; nonhemolytic streptococcus, 2; Staphylococcus epidermidis 1; Staphylococcus aureus, 2; no growth, 1; and pneumococcus, 20—divided into the following types—type I, 15; type V, 2; type VIII, 1; type I and III, 1; not given, 1. In 1942 there were: Staphylococcus aureus, 2; nonhemolytic streptococcus, 2; pneumococcus, 12, of the following types—type I, 8; type III, 1; type V, 3; spirochetae, fusiform bacilli, and nonhemolytic streptococcus, 1.

TREATMENT

Once empyema has occurred the sulfonamides do not aid in the cure of the disease. The pus must be evacuated by aspiration, closed or open drainage. Rib resection and open drainage were done in 89 per cent, in 1936; 89 per cent, in 1937; 86 per cent, in 1938; 91 per cent, in 1939; 92 per cent, in 1940, 96 per cent, in 1941; 100 per cent, in 1942. Repeated aspirations were done in 14 cases, closed drainage was done in 3 cases. Two of these were later operated upon by rib resection. Spontaneous resolution was not observed before or since the use of sulfonamides. However, it should be said that, in the streptococcus varieties, localization is hastened by the use of the drugs.

Anyone who has treated children with empyema has been impressed with the necessity of early open drainage in preventing complications such as suppurative pericarditis, multiple pocket formation, chronic empyema and septicopyemia. They must also be aware of the danger of open drainage before localization has occurred.[1] Formerly the proper time for such drainage was based upon the consistency of the pus obtained by aspiration. However, we have observed that pus may be thick very early in the disease when sulfonamides have

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[1]Since submitting this paper for publication we have observed 1 case of "putrid" empyema following lung abscess. Fixation of the diaphragm and mediastinum was present on admission to the hospital. Since many of the causative organisms in such patients are anaerobes, immediate open operation is imperative.

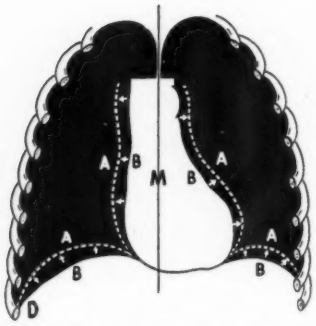

Fig. 1. Diagram indicating normal excursions of diaphragm and mediastinum as observed by fluoroscopic examination. *D*, Diaphragm; *M*, mediastinum. *B*, Diaphragm descends and mediastinal shadow is narrower on inspiration; *A*, diaphragm ascends and mediastinal shadow is wider on expiration.

been used. Lanman and Heyl have reported similar observations. This change in consistency may precede localization. Furthermore we have found in children not treated by such drugs that localization may occur before the pus becomes thick (1). Burford and Blades point out that the transition from effusion to frank pus is prolonged in cases in which sulfonamide therapy has been employed. Our experience seems to substantiate the observation that the illness is prolonged although here again great seasonal variations are noted. In 1936 the average hospital stay for patients treated by rib resection was 34 days. The average stay before operation was 11 days and after operation 23 days. In 1941 the average hospital stay for patients treated by rib resection was 49 days. The average stay before operation was 11 days and after operation 38 days. In 1942 the average hospital stay was 40 days; before operation 14 days, and after operation 26 days. The clinical and laboratory symptoms and signs such as the temperature, the appetite, and leucocyte counts cannot now be relied on. When the temperature was of the septic type, the appetite poor, and there was a high leucocytosis, one felt sure that pus was under pressure and should be drained. However, the fever curve is no guide when the sulfonamides are given, and they produce anorexia in most children. Also the leucocyte counts may not be reliable as guides for surgical intervention when these drugs are used.

FLUOROSCOPIC OBSERVATION

In his splendid review of the literature on nontuberculous empyemas, Ehler thought that our method would provide "valuable information concerning the proper time for drainage" but that "the interpretation of the findings requires considerable experience and familiarity with intrathoracic dynamics." During the past 6 years we have developed some practical maneuvers in the fluoroscopic examination of empyema patients, which have greatly simplified this method.

The fluoroscope is important to determine (1) whether or not localization has occurred and (2) the position of the encapsulated and interlobar varieties of empyemas. The method is based upon the fact that with localization comes fixation of the walls of the empyema cavity. In children, as we have stated, empyemas are usually massive so that fixation of the movable diaphragm and mediastinum are accurate guides. The mediastinum does not change as much in adults. However, even in localized cavities the phenomenon of fixation of the surrounding lung can be demonstrated.

In the normal child the diaphragm descends on inspiration and the mediastinal shadow becomes narrower. On expiration the reverse is true (Fig. 1).

In the child with empyema a thoracentesis is done to determine the type of organism, partially to empty the cavity of pus, and also to inject air. First the child is observed in the upright position. The fluid level is easily seen and before localization moves with respiration (Fig. 2). It descends with the diaphragm on inspiration and ascends on expiration. After localization two phenomena have been observed: (a) no movement—this is seen in bilateral and sometimes unilateral empyema; (b) paradoxical movement—this is seen in unilateral empyema due to an exaggerated movement of the opposite leaf of the diaphragm. We believe that the large excursion of the unaffected diaphragm increases intra-abdominal pressure on inspiration and forces the fixed side upward—the converse may be true during expiration (Fig. 3).

It would be impossible to observe the movement of the diaphragm with the patient in the flat or upright position because pus obscures

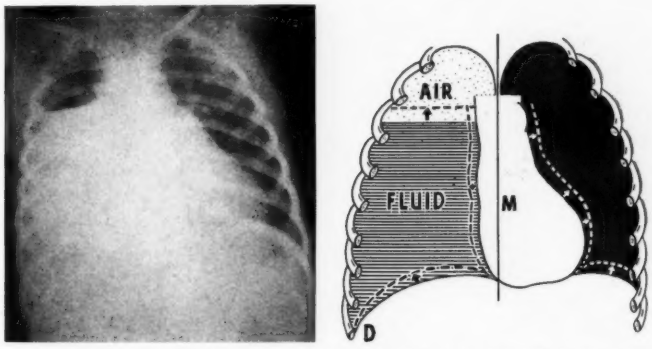

Fig. 2. Empyema of right pleural cavity. The child is in the upright position. Fixation has not occurred. On the left is an x-ray photograph, on the right a diagram illustrating fluoroscopic observations. Both leaves of the diaphragm and both sides of the mediastinum move with respiration. As the diaphragm descends on inspiration the fluid level moves down and on expiration it moves upward.

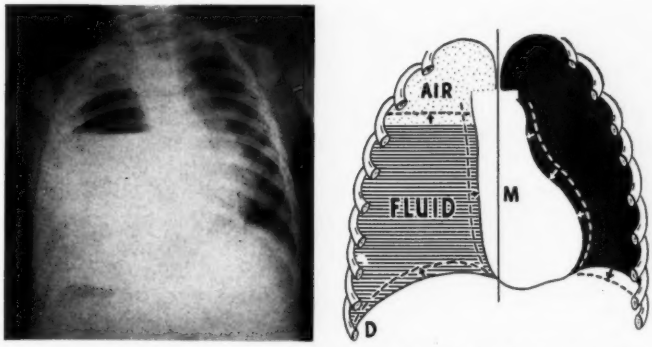

Fig. 3. Patient in upright position. Empyema thoracis (right) after fixation. Paradoxical movement with deep inspiration, the left diaphragm descends and the left mediastinal shadow moves mesially. The right diaphragm ascends and the fluid level moves upward.

the contour of the diaphragm and on the right side the liver also adds its dense shadow, making such observation difficult (Fig. 2). However, with the patient tilted in the head-down (Trendelenburg) position the diaphragm can be seen easily if a sufficient amount of air is present in the empyema cavity (Fig. 4). Small amounts of air are seen in the costophrenic angle only and are of no aid; 20 to 30 cubic centimeters of pus or more is aspirated and an equal amount of air is injected. Fixation of the diaphragm implies localization.

A third maneuver enables us to observe the mediastinum. The patient is turned on the affected side and is observed in the anteroposterior (lateral decubitus) plane. The pus gravitates away from the mediastinum permitting observation of its movements. If this is fixed the cavity is completely localized and open drainage may be safely done (Fig. 5).

MORTALITY

In our previous study we reported 123 cases of nontuberculous empyema caused by the pneumococcus, streptococcus, and staphylococcus in which patients were treated with fluoroscopic observation, and of which 100 had rib resections. The mortality in this group was

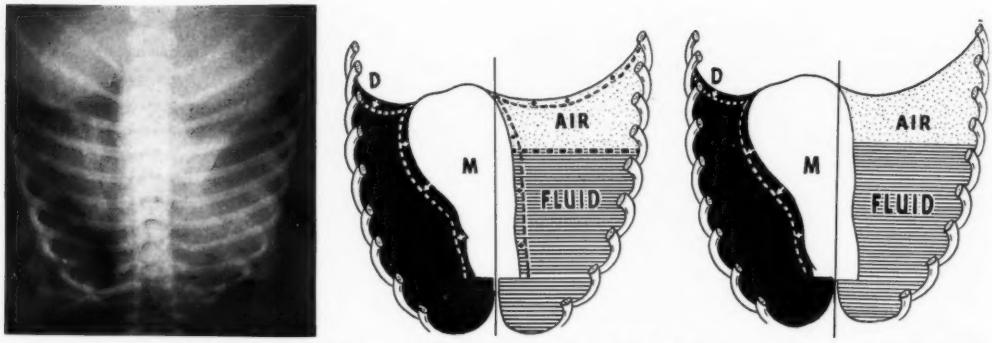

Fig. 4. The patient is in the Trendelenburg position. On the left is a roentgenogram. On the right are diagrams illustrating fluoroscopic observation of the diaphragm. The center illustration depicts movement of the diaphragm cephalad (arrows) during expiration; air space decreased. It is the movement of the diaphragm that is observed. Illustration on right shows fixation of diaphragm. Note band of adhesion to diaphragm in the roentgenogram.

4.9 per cent. We also reported 27 cases in which patients were treated by early rib resection which was possibly due to the aid of fluoroscopic examination. There was no mortality or complication in this group and the hospital stay was much shorter. No irrigations were employed. The fluoroscope was also used to determine the proper time for removing the tube. When no fluid could be seen the tube was removed. This was possible in 8 to 10 days in pneumococcic types.

Mortality rates since 1936 were as follows:

	Cases	Death	Per cent
1936	45	4	8.8
1937	35	3	8.5
1938	28	4	14.2
1939	22	1	4.5
1940	12	1	8.3
1941	25	1	4.0
1942	17	0	0
Totals	184	14	7.6

An analysis of these deaths shows that of the 167 cases in which patients were treated by rib resection there were 5 deaths, a mortality rate of 2.9 per cent. The deaths in this group were as follows: (1) a boy, aged 15 years, with perforated appendicitis, spreading peritonitis, subphrenic abscess and Bacillus coli empyema; (2) streptococcic empyema in a 17 month old girl with brain abscess; (3) pneumococcic empyema in a boy 2 years old with cerebral embolus; (4) pneumococcic empyema in a girl aged 2 with pneumonia in opposite lung; (5) a boy aged 2 years with rheumatic heart disease and type VIII pneumococcus empyema.

There were 9 deaths in patients treated by aspiration or closed drainage. These were as follows: (1) an 8 year old girl with pneumococcus empyema *in extremis*, who died 48 hours after admission to the hospital; (2) a 2 year old boy with hemolytic streptococcic empyema following scarlet fever and bronchopneumonia who also had interstitial nephritis; (3) a 13 year old boy with chronic suppurative otitis media, mastoiditis, and septicemia who had received prontylin; (4) a 6 year old boy with perforated appendicitis, peritonitis, lung abscess, pneumothorax, spontaneous subcutaneous emphysema; (5) a 1½ year old girl who entered the hospital with a temperature of 107 degrees and a leucocyte count of 37,100 (type VI pneumococcus was isolated from sputum) died 2 hours after admission; (6) an 11 year old boy with type V pneumococcus empyema, who died 48 hours after admission; (7) a 2½ year old girl with type V pneumococcus who had received sulfapyridine and died 36 hours after admission; (8) a 3 day old boy with Staphylococcus aureus empyema, whose death was due to staphylococcus septicemia and who had received sulfathiazole; (9) an 11 month old girl with type V pneumonia and empyema, who received sulfathiazole and whose death occurred 3 days after admission. Most of the deaths—71 per cent—occurred before the advent of the sulfonamide drugs. However, in our previous study we reported 27 consecutive cases in 1935 without a death or complication. This is indicative again of the

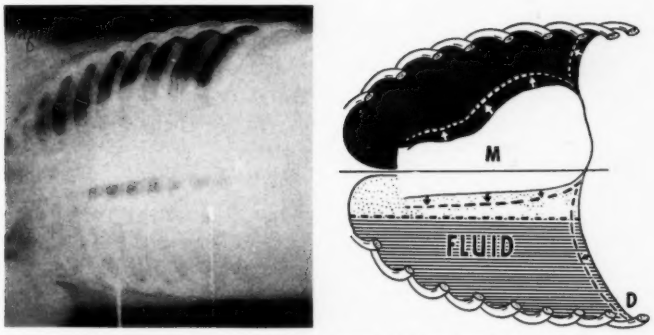

Fig. 5. Empyema thoracis (right) observed with patient in lateral decubitus position. On the left is a roentgenogram showing the fluid level after aspiration and injection of air. On the right is an illustration depicting the movement of the diaphragm and mediastinum. With expiration the diaphragm moves upward and the mediastinal shadow widens (see arrows). The air space is narrowed. It is the movement of the mediastinal shadow that is observed. After fixation there is no mediastinal movement on the affected side.

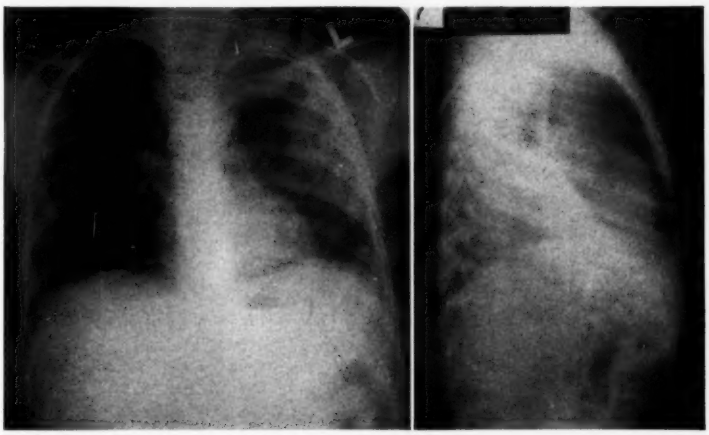

Fig. 6. Localized types of empyema. a, Small encapsulated cavity; b, interlobar empyema in fissure between upper, middle, and lower lobes at the level of the fifth rib.

great yearly variation in the severity and frequency of the disease.

It should be noted that the children treated by aspirations or closed drainage were either in too critical condition for open operation or, if observed by the fluoroscope, it was found that localization had not occurred and therefore the open operation could not be done.

COMPLICATIONS

The number of complications varies from year to year. However, there does seem to be a decrease since the sulfonamides have been used. In 1936 in addition to the 4 deaths reported, the following complications were observed: draining sinus, 1; pneumonia on opposite side, 1; chronic empyema with toxic arthritis, 1; bronchial fistula, 2; and 2 children were admitted because of chronic empyema—15.5 per cent of the patients treated. In 1941 and 1942 in addition to the 1 death reported, there were 1 subcutaneous abscess, 1 glomerulonephritis, and 1 bronchopleural fistula—7 per cent of the patients treated.

SUMMARY

1. Rib resection with open drainage is the method of choice in treating empyema thoracis in children.

2. Since the advent of the sulfonamide drugs the use of the fluoroscope is necessary to determine the proper time for this procedure. This is true because other criteria such as the character of the pus, leucocyte counts, and temperature range, are not reliable guides when the sulfonamides are employed.

3. Methods of fluoroscopic observation are described.

4. A study of 184 cases of empyema before and since the use of the sulfonamides reveals the following observations: (a) The incidence of the disease varies from year to year and is apparently uninfluenced by their use; (b) there is a greater incidence of localized types of empyema; (c) streptococcic and staphylococcic varieties are not as serious as formerly; (d) the stay in the hospital is prolonged; (e) the mortality is much less; (f) complications are less frequent.

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INJURIES OF THE PARIETES AND EXTREMITIES

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The Care of Wounds under Emergency Conditions

IN the foregoing discussion of wound treatment it is assumed that the patient comes to the surgeon promptly after injury and that there are adequate facilities, assistance, and time to permit him to carry out the surgical procedure indicated. When one is suddenly confronted with a large number of injured patients, as after a fire, explosion, tornado, and air raid or under conditions of war, one must adapt the treatment to the conditions at hand. Organization and foresight can help immeasurably though no amount of planning and preparation is effective unless cool heads are available when the critical moment arrives.

Under conditions of stress and with inadequate facilities for carrying out surgical treatment one can accomplish the greatest good for the greatest number by giving skillful first aid care and sending patients as promptly as possible to hospitals where adequate surgical care can be given.

What constitutes the simplest form of skillful first aid treatment? The removal of any free foreign bodies, implantation of a sulfonamide in the wound so that its bacteriostatic action may arrest bacterial activity, the application of a large sterile dressing, bandaged with moderate pressure, and of a splint to immobilize the injured extremity. For the majority of patients such primary treatment is adequate. For the complications which demand immediate attention, namely shock and hemorrhage, special provision must be made.

If well planned, emergency treatment can be carried out rapidly and efficiently for a large number of patients and with a minimum number of highly trained personnel. In other words nurses, hospital orderlies, and the personnel of medical regiments under the direction of only a few surgeons can render invaluable aid if the principles stressed above are kept in mind: namely, not to add infection to the open wound; not to add further trauma.

It is not difficult, for example, to visualize an "assembly line" which consists of very simple equipment: two or three rows of wooden supports upon which stretchers can be rested, and opposite them tables with sterilizing units, instruments, sterile dressings and material for splints (Fig. 26). At the entrance to the tent or hut is a supply of masks, and as the stretcher is put down before the examining surgeon stretcher bearers and patient are masked. Needless to repeat all personnel within the tent or hut are masked.

The surgeon, one of the most experienced men of the group, must decide quickly whether the patient should be taken immediately to the "shock tent" *A*, whether he should be taken to the surgeon at *B* because his blood soaked dressing indicates that active bleeding is going on, or whether he can be entrusted for the application of the dressing to trained nurses and orderlies at *C*. If after the patient's dressing is applied he requires more than a simple immobilizing splint he can be taken to *D* where the splint team is provided with equipment for immobilizing fractures of long bones and for complicated cases.

Such a unit could function with only a few well trained surgeons: one as diagnostician to decide what should be done immediately; one to care for patients with bleeding wounds; one to supervise the whole, to direct the treatment of shock and supervise the application of dressings and of splints. An anesthetist to aid the operating surgeon with nitrous oxide or an intravenous anesthetic, and a dental surgeon skilled in the use of plaster to direct the splint team could give invaluable assistance.

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Obviously such a simple scheme could be expanded indefinitely in proportion to the personnel and equipment available. Experienced surgeons would agree, however, that under emergency conditions *several units of relatively small size and physically separated* can render more efficient service than a single large unit which may easily be handicapped by lack of adequate facilities for entry and exit and for transporting patients.

In the first World War, for example, it was found advantageous to arrange casualty clearing stations in groups of two or three. In times of stress one station would admit 100 or 200 patients and then the stream of wounded be diverted to the next station, so that a bottle neck would not develop near the head of the line due to difficulties in caring for the patients first admitted.

Not the least important element in the success of a plan for caring for a large number of patients in a short period of time is the choice of a site for the first aid station. It should be placed so that ambulances and trucks can be unloaded and leave without interfering with incoming vehicles; and permit evacuation of treated patients without interfering with the transport of incoming patients. The most efficient use of transport would result if ambulances freed of their load of incoming patients could pass on to the exit of the station and take on patients ready for evacuation to hospitals where adequate surgical care could be given.

CHEMOTHERAPY IN THE TREATMENT OF WOUNDS

Many investigators have emphasized the fact that bacterial contamination is a common occurrence in open wounds, whether accidental or the result of surgical incision. Ives and Hirshfield, for example, reported that in 30 clean surgical cases bacteria were recovered from all the wounds. In a recent study Pulaski, Meleney, and Spaeth found bacteria present in every one of 200 fresh untreated traumatic wounds. In neither report was it stated what percentage of the organisms found were pathogenic. In Ives and Hirshfield's series infection developed in only one case. No statement is made in Pulaski, Meleney, and Spaeth's paper as to the results of treatment except that "no cases of gas gangrene and no cases of tetanus developed in the wounds from which these organisms were grown (46 cases, 23 per cent of the total), treatment being instituted to prevent their activity."

The general recognition of the fact that bacteria are constant contaminants of open wounds has been the dominating factor in the constant search for means of destroying the bacteria; and this effort, often directed by individuals without surgical training, has not infrequently ignored certain fundamental facts, namely, that not all bacteria present in open wounds are pathogenic; that centuries ago man was forced to develop an effective immunity to pathogenic bacteria; and that this natural defensive mechanism is most effective when body tissues are uninjured, when no blood clots are present in the wound, and when the affected part is kept at rest.

Furthermore, as Lyons and Burbank have pointed out in their excellent review on local sulfonamide therapy, successful chemotherapy depends upon the specific effect of a drug upon a specific infectious agent, as exemplified in the treatment of syphilis and malaria.

"The topical application of sulfonamide crystals is contrary to this fundamental concept of chemotherapy in two respects. First, there is established locally a concentration of drug known to be toxic systemically. Secondly, it is proposed to broaden the action of the drugs to include an effect upon relatively insensitive bacteria by increasing the concentration of the chemical agent . . . The proposal to use sulfonamides as a prophylactic agent against polymicrobial wound infections marks another departure from conventional thinking. Factual data . . . demonstrate that systemically toxic concentrations of sulfonamides are at least locally tolerated and that a wider antibacterial action is partially achieved by these higher concentrations. In evaluating the importance of this work the emphasis should be upon the broadened concept of chemotherapy rather than upon sulfonamides.

"There is a striking lack of critical evidence in regard to the effect of locally implanted sulfonamides upon wound healing. Apparently the cells can recover from the toxic effects of sulfonamides if transferred to an environment completely freed of the drugs but there is no information as to the rate of recovery of poisoned cells upon transfer to a medium containing a lesser concentration of drug. The variable factors of solubility and local persistence of the drugs and the advisability of parenteral supple-

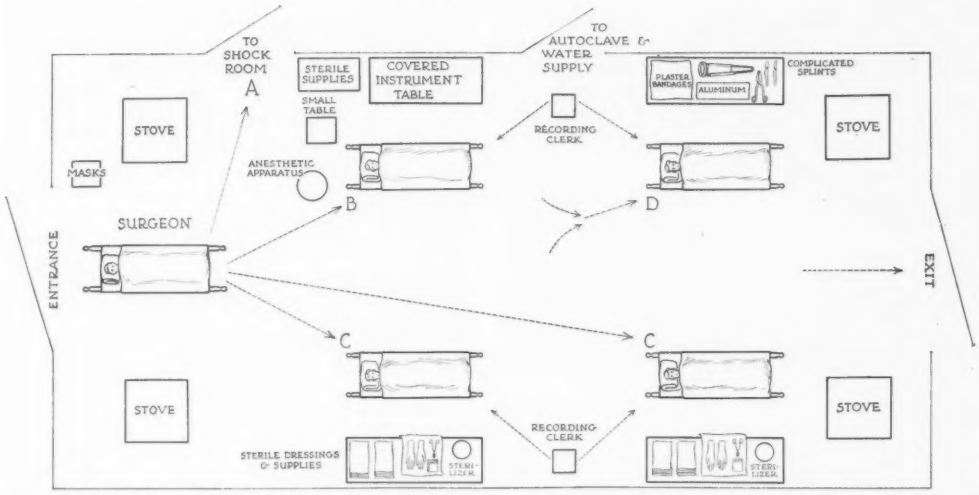

Fig. 26. A simple scheme for giving first aid under emergency conditions to a large number of patients. Stretchers are placed on wooden horses. Patients are sent by the examining surgeon to the shock room or tent, to the operating surgeon at B for control of active hemorrhage, or to trained personnel at C for simple wound dressing. Complicated splints, if needed, are applied by a splint team at D.

mental therapy must be considered in this regard. Further experimental evidence must be available before the effect of locally implanted sulfonamides upon wound healing can be properly evaluated.

"Sulfonamide powders may be partially sterilized by dry heat at 120° C. for one-half hour and dusted onto open wounds in doses not to exceed 1 gm. per 10 sq. in. of exposed surface. For intraperitoneal use the dosage should never exceed 5 gm. and 10 gm. should be the maximal dosage for any wound.

"Sulfanilamide is absorbed more rapidly, excreted more readily, persists as crystals and chemically in the wound for the shortest period of time and is more soluble in serum than the other sulfonamides. Sulfathiazole, sulfadiazine, and sulfapyridine follow in an order of decreasing solubility. These facts may serve as a basis of selection of a particular drug or combination of drugs for local application. For intraperitoneal use sulfanilamide seems to possess the advantage of ready solubility. The more rapid absorption decreases the risk of a local foreign-body reaction capable of producing adhesions and subsequent intestinal obstruction. In the management of extraperitoneal wounds with infrequent opportunity for a change of dressings it would appear desirable to combine sulfanilamide and sulfadiazine to insure rapid diffusion of the drug throughout the wound and a prolonged local effect. Sulfadiazine is preferable to sulfathiazole because it is less toxic for cells. The failure of the sulfonamides to diffuse readily into dead and devitalized tissues argues for a preliminary meticulous toilet of the compound wound....

"It should be emphasized that the sulfonamides are normally bacteriostatic and not bactericidal, although bacterial death has been achieved in the presence of physiological elevations of temperature (40°C.).

"The rather enthusiastic clinical adoption of local sulfonamide therapy has failed to provide factual data for analysis of the extent to which such treatment has prevented the growth of bacteria in wounds. The results are encouraging but final evaluation is dependent upon more careful study of the bacteria present in the wounds at the time of treatment and observation of the eventual fate of those bacteria" (Lyons and Burbank).

Fleming has also emphasized the fact that:

"The sulfonamide drugs are essentially bacteriostatic, i.e. their actual bactericidal powers are small as compared with their power of inhibiting the growth of sensitive bacteria. The final destruction of the bacteria has to be accomplished by the natural defenses of the body, and it follows that the more effective are these defenses the more effective will the result of sulfonamide treatment appear."

It is not unjust to say that overemphasis has been placed on clinical results obtained in cases in which exact information as to the presence of pathogenic bacteria, their type, number, and virulence has been lacking. Most surgeons are agreed that we need more information on a number of basic points.

1. What are the pathogenic bacteria commonly present in contaminated wounds?

Fig. 27. Left, A dressing cart is of invaluable service in helping to apply dressings quickly and easily and to maintain an aseptic technique. The porcelain jars contain (from left to right) sterile towels; large dressings, 4 by 4 inches; smaller dressings, 3 by 3 inches; sterile applicators, medicine glasses and tongue blades. Safety pins, benzine, 95 per cent alcohol, soap solution, collodion, Dakin's solution in a dark brown bottle and boric solution in a flask stand in front of the jars. Petrolatum gauze is kept in the smaller covered porcelain tray and sterile instruments in the larger. Sterile petrolatum and zinc oxide ointment are kept in small covered porcelain containers. Cast cutting knife, bandage scissors and dressing forceps in a mason jar are easily accessible. Basins on arms which swing out from under the top serve as containers for soiled instruments. On the lower shelf are large sterile pads wrapped in muslin, a sterile basin, gloves, sterile irrigating syringes wrapped in muslin, bandages, and a large basin for soiled dressings. A paper bag strapped to the end of the cart contains folded newspaper on which to lay soiled dressings as they are removed from the wound.

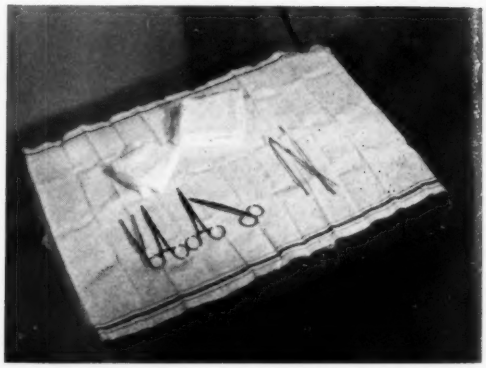

Fig. 28. Before a dressing is applied a sterile towel is laid on the bedside table and on it instruments and sterile dressings. With a little practice one can change a dressing quickly, and still have it sterile, except for the outermost layer, and one's fingers free from wound secretions.

2. In what proportion of open wounds are such bacteria present?

3. What is their source?

4. Can these bacteria be eliminated in greatest part by simple mechanical cleansing that does not injure living tissue?

5. If simple wound cleansing is effective within 2 hours after injury, how long afterward is it still effective?

6. Do chemical agents—the sulfonamides in particular—prevent the development of infection in a wound contaminated with pathogenic bacteria?

7. How can they be used to best advantage?

Many serious efforts are being made to find the answer to these questions, and it is not too much to hope that a definite, logical, and more effective method of preventing infection of open wounds than has been available in the past will be evolved in the near future.

INFECTED WOUNDS

The care of infected wounds is so well described in modern textbooks of surgery that it is needless to discuss it again in detail. A brief summary of the surgical principles involved, however, may add to the completeness of a discussion of the treatment of wounds.

With infection present in an open wound the first problem is one of diagnosis. Before logical and effective treatment can be initiated the surgeon must answer three questions:

1. Is the infection a diffuse spreading infection, or is it localized?

2. If it is localized, what is the site of localization?

3. What is the causative organism or organisms?

It is a well recognized surgical principle that in the presence of an acute spreading infection, except in some types of infection due to anaerobic bacteria, active surgical treatment is contraindicated, and the surgeon will achieve the best results by abstaining from operation and by doing everything in his power to increase the patient's resistance, to combat the infection by specific chemotherapeutic agents, if such are available, and to employ local treatment which will help to limit and localize the infection. Absolute rest, maintenance of fluid intake, of nutrition and elimination are cardinal and well recognized

obligations. Specific chemotherapy, if the causative organism is known, blood transfusion from immunized donors (Lyons) and in certain cases the use of heparin can be of very great help. Sulfanilamide and sulfadiazine have proved to be of lifesaving value in cases of acute spreading streptococcus infection, the most common and most dreaded form of acute spreading infection. Sulfathiazole, heralded as of particular value in staphylococcus infection has not proved as effective as had been anticipated. The control of staphylococcus infection is still a baffling problem. Recent work with penicillin has given promising results, and the first report of its clinical use on a large scale appeared recently in a preliminary report by Faxon and Churchill of the treatment of a large group of burned patients at the Massachusetts General Hospital. Locally, the application of large warm wet sterile dressings that help to maintain the circulation at a maximum and elevation of the affected part to aid in the return circulation and delay the onset of passive congestion are of definite value in helping to bring about localization of the infection and in relieving the pain of acute inflammation.

The symptoms of an acute spreading infection are familiar to every third year medical student: high fever, rapid pulse, prostration; diffuse inflammatory reaction of skin and soft tissues, increasing in extent and intensity as the hours go by; and red streaks extending proximalward from the site of infection—warning signals of a virulent infection spreading along the lymphatic vessels.

Confronted with such a picture it is obvious that the surgeon is dealing with a diffuse invasive process which cannot be helped by local incision, but which may be greatly aggravated by any surgical interference with nature's effort to combat and localize the infection. Since it is often impossible quickly to identify the cause of the infection one must resort to the empirical use of sulfonamides because of their demonstrated value in arresting rapidly spreading infection, but remembering that the available drugs may not be specific for the infection present, that some organisms are sulfonamide resistant, and that although the causative organisms may be rendered bacteriostatic by the drug given the mechanism that destroys bacteria in the blood stream and body tissues may not function normally and the infection may continue and progress. The importance of giving sulfonamides in sufficient amounts to secure as promptly as possible a blood concentration of 7 to 10 milligrams per cent has been stressed repeatedly by Long, Lockwood, and many others. The necessity for maintaining adequate fluid intake and elimination and for watching the patient carefully for signs of toxemia, retention, and renal involvement has been repeatedly emphasized.

In the presence of localized infection the surgical principle of *securing adequate drainage with minimum injury of essential structures* is the first consideration. This necessitates accurate diagnosis as to the site of infection. In some cases the diagnosis may be obvious; in others recognition of the exact location of an accumulation of pus requires thoughtful consideration and interpretation of the symptoms the patient presents. Many a hand, for example, has been irreparably injured because of the failure to make a correct diagnosis as to the location of pus formation; and secondly by failure to consider how the infected area might be drained with minimum injury to soft tissues, nerves, blood vessels, and tendons.

After an infected area has been drained the wound must receive cleanly surgical care until healing is complete (Figs. 27, 28). One of the commonest errors in surgical practice, both in hospital and office is the addition of further infection to that already present. Just as in the immediate care of open wounds unmasked faces, unclean hands, instruments incompletely sterilized carry a constant threat for the patient with an open wound. Anyone who has seen the telltale bluish-green color of pyocyaneus infection appear on the dressings over a wound, and watched the appearance of the identical color on the dressings of one patient after another throughout the ward cannot doubt that the streptococcus, staphylococcus, and other types of virulent organisms can be carried from one patient to another in the identical fashion in which the Bacillus pyocyaneus is so often inoculated in the wounds of successive patients.

UNUSUAL TYPES OF INFECTION

A special word should be added concerning unusual types of infection, because they demand unusual treatment.

Gas gangrene is a spreading infection, often rapidly spreading, which, in contrast to rapidly spreading pyogenic infections, requires active surgical treatment. A foul smelling discharge, which in the early stages may consist only of hemolyzed blood, from a wound received on the street, on a dirty road, or as the result of a penetrating injury, and particularly if the injury has been of a crushing nature and has involved muscle tissue, should always suggest the possibility of infection with a virulent anaerobic organism of the group typified by the Clostridium welchii. If in addition to the characteristic wound discharge and history of injury the edges of the wound are blackened, and the skin about it mottled with a greenish yellow discoloration similar to that resulting from breaking down of blood cells in the subcutaneous tissues, one can be fairly certain that microscopic examination and cultures of the wound discharge will show the characteristic rod shaped Clostridium welchii or another of the organisms that produce gas gangrene. The escape of bubbles of gas when pressure is applied over the edges of the wound, and the demonstration of gas in the tissues by x-ray examination are late symptoms of diagnostic value, but symptoms that indicate an advanced process and a grave prognosis.

The treatment is prompt excision of the involved tissue, which often means excision of an entire muscle or group of muscles because the infection tends to progress proximalward and distalward within the substance of a muscle and to remain confined, at first, to the muscle or muscles primarily infected. Sulfadiazine, zinc peroxide (Meleney) which furnishes a slow and constant supply of oxygen to the wound area, and serum which is active against Clostridium welchii and vibrion septique are all helpful in bringing about arrest of the infectious process. Irradiation of the affected area has been strongly advocated by Kelly. Because gas gangrene is relatively uncommon, even among war wounded and air raid casualties, the most effective method of treatment, apart from excision of the affected tissues, and the relative value of the methods mentioned are still not definitely determined.

Chronic undermining ulcers resulting from infection with the microaerophilic hemolytic streptococcus have been well described and successfully treated by Meleney. He has constantly emphasized careful study of the bacteriological flora and recognition of the causative microaerophilic hemolytic streptococcus, complete excision of the overhanging undermined edges of the ulcer and of sinuses leading from it, and daily dressings with a creamy suspension of active zinc peroxide, applied in such a way that the oxygen is slowly liberated during a period of 24 hours. When the infection is brought under control the extensive open wound is covered with skin grafts.

Bacterial synergistic gangrene has also been particularly well described by Meleney. He has emphasized as diagnostic criteria the constantly widening ulcer which forms as the gangrenous skin sloughs; the advancing, reddish purple or bluish purple indurated border, exquisitely painful and sensitive to pressure; and the constant presence on culture of a microaerophilic nonhemolytic streptococcus in the advancing margin and of a hemolytic staphylococcus in the gangrenous portion. This condition has consistently yielded in Meleney's hands to cautery or knife excision of the entire indurated margin, cleanly surgical care, and finally covering of the raw surface with skin grafts.

BURNS

In spite of the many and excellent discussions that have appeared in recent surgical literature with reference to burns it should be emphasized again that burns are large open wounds, and the same principles of treatment apply that have been stressed in the general treatment of wounds—conversion of the contaminated wound into a clean wound, application of an occlusive dressing that provides pressure, and provision for complete rest of the injured part. Siler has focused attention on this method by the apt and concise phrase "primary cleansing, compression and rest treatment of burns." There is little argument among surgeons as to the necessity of anticipating and combatting shock, and methods

of doing so are fairly well agreed upon. Unfortunately, there is as yet little agreement concerning the most satisfactory method of local treatment of the burned area.

A primary consideration is conversion of the contaminated wound into a clean wound by the simplest method that does not add further contamination and further injury. That method, in our minds, is not with the aid of chemicals but with simple, nontraumatizing soap and water cleansing carried out with cleanly surgical technique. When it has been accomplished, and loose destroyed tissue lifted or cut away with sterile instruments, the open wound is covered with a nonadherent dressing, such as a single layer of fine meshed gauze saturated with vaseline, that does not fix or coagulate tissue and that, although nonadherent, permits the escape into the outer covering dressing of the exudate, the "white hemorrhage," that escapes from the burned surface until it is arrested by pressure. Compression is provided by sterile gauze, and by mechanics' waste or sea sponges outside the sterile gauze bandaged under moderate tension, preferably with an elastic bandage such as a stockinet. Not only does such compression arrest escape of plasma from the surface, but it checks the escape of serum into the cellular tissue underneath the surface and helps to limit the vital loss of fluid into the deeper tissues that is such an important factor in the production of shock.

The advantages of such a method of treatment are many. (1) It is simple and concluded in one stage. After the dressing is applied a splint is added, if the burn involves an extremity, and the patient left alone. (2) The chances of adding further contamination are reduced to a minimum. (3) The deeper layers of the skin, if still present to furnish a source for regeneration of the skin covering, are not fixed by a chemical coagulant. Expressed a little differently, if only a thin layer of the corium or dermis is left undestroyed by the original injury the few remaining epithelial elements which might furnish a source for reformation of the covering skin are not rendered inert by application of a chemical coagulant. (4) If the effort to convert the contaminated wound into a clean wound is unsuccessful and infection develops, removal of the dressing to permit recognition of the affected area is a simple procedure. The difficulty of recognizing the exact site of infection under an extensive coagulum and of gaining access to it has disturbed many a surgeon in the care of a severely burned patient. (5) The advantage of providing adequate pressure over the affected area and at the earliest possible moment has been emphasized. A coagulant crust cannot provide the same degree of pressure nor provide pressure promptly. Every surgeon who has employed coagulant dressings recognizes the fact that exudation into the deeper tissues of the burned extremity, not from the burned surface, continues until it is checked by coagulation or by the increasing interstitial pressure in the tissues underneath the burned surface. The shock which is of such concern to the surgeon who is treating burned patients can be reduced, at times averted, by preventing the loss of plasma into the body tissues.

If the patient is seen late, and the burned area has already been covered with grease or ointment the advantage of cleansing the raw surface and applying a dressing which does not coagulate the surface and which can be removed with minimum difficulty is obvious. In such cases, too, the use of a chemotherapeutic agent to combat infection can be of great value. The most helpful method of utilizing the sulfonamides in such cases is receiving serious attention in a number of surgical clinics, but it should be emphasized that it is in patients with large open wounds in whom control of fluid balance may be difficult or impossible at the moment that there lies the greatest danger of rapid absorption, of inadequate elimination and resulting toxemia.

If the patient comes with a frankly infected wound the problem is similar to that of any other infected wound, but aggravated by the extent of the injury, the circulatory damage that has taken place, and the possibility that a virulent infection may be present.

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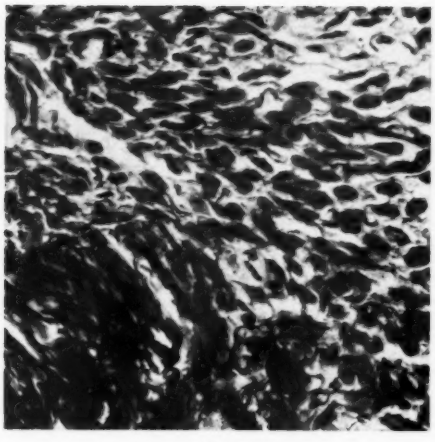

Fig. 4

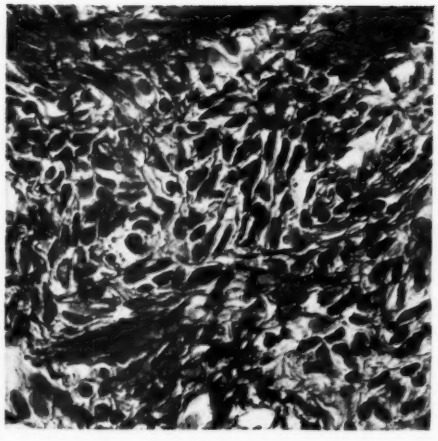

Fig. 5

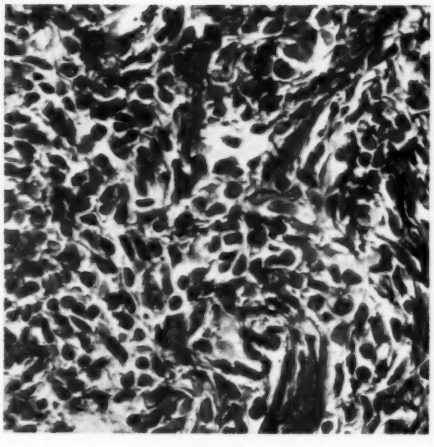

Fig. 6

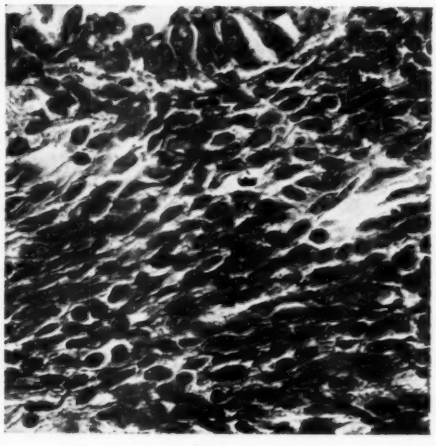

Fig. 7

Fig. 4. Normal endometrium. Zone of transition between myometrium (lower left) and endometrium (upper right). The stroma is dense and compact in the myometrium, fine and delicate in the endometrium. (Heidenhain's aniline blue stain, ×500.)

Fig. 5. Adenomyosis. Intermingling of myometrial and stromal cells. The chief differences are the shape of the cells and the character of the stroma. (Heidenhain's aniline blue stain, ×500.)

Fig. 6. Adenomyosis. Myometrium at right, endometrium at the left. The transition is so gradual that many cells cannot be classified as belonging to either layer. (Heidenhain's aniline blue stain, ×500.)

Fig. 7. Adenomyosis. The delicate connective stroma of "interstitial" cells can readily be seen. An endometrial gland is seen at the upper edge. The transition from the myometrium can be seen at the lower edge. (Heidenhain's aniline blue stain, ×500.)

Adenomyosis of the Uterus.—Osborne A. Brines and James H. Blain

ADENOMYOSIS OF THE UTERUS

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ADENOMYOSIS may be defined as the heterotopic occurrence of islands of endometrium within the myometrium or uterine wall. It is distinct from endometriosis in which disease the heterotopic endometrium is situated outside of the uterus.

Under the title of "Ueber Uterusdruesenneubildung im Uterus," adenomyosis was first described by Rokitansky in 1860. German and Viennese pathologists and gynecologists, particularly Frankl, first consistently employed the term adenomyosis. In an article published in 1932 Frankl (13) states that he was first to recognize the condition as an entity and to describe it as such, microscopically and otherwise, in 1912. Much of the literature has been confusing, with overlapping and interchanging of the terms adenomyosis, adenomyoma, and endometriosis. The important contributions to the subject in general by Babes in 1881, Cullen (6) in 1908 and Sampson (30, 31) in 1921 and 1922 must be accorded full recognition. In 1896 von Recklinghausen published an article on the subject. In 1914 Cullen (7) reported 70 cases of adenomyoma of the uterus collected from the gynecological clinic at Johns Hopkins Hospital. It seems quite likely that the majority of the cases reported at that time and since as adenomyoma were really adenomyosis.

In addition to the various terms employed as synonyms for endometriosis, adenomyosis has been referred to as adenomyoma, adenomyomatosis, internal and external uterine endometriosis, von Recklinghausen's disease, adenometritis, adenomyositis, and adenomyometritis, the last three being particularly inappropriate. It might be suggested that if adenomyosis were not the term employed, uterine or intrauterine endometriosis would probably be of second preference. While adenomyosis is frequently included under endometriosis, it is usually not difficult for the interested reader or listener to distinguish the two lesions. Internal and external endometriosis are employed, the former meaning adenomyosis of the uterus and the latter meaning extrauterine endometriosis, and to make the subject more confusing, external endometriosis is occasionally used to mean adenomyosis of the outer portion of the uterine wall.

The approach to this subject has been rendered difficult because of the confusion in terminology and the failure to distinguish precisely between adenomyosis, adenomyoma, and endometriosis in the earlier literature dealing with this disease. The more recent literature has by no means clarified the subject. The greatest confusion concerns adenomyosis and adenomyoma. To some extent the term adenomyoma has been used synonymously with adenomyosis, the former being widely used to connote what we now prefer to call the latter. The two lesions are distinctly different and yet in the earlier reports discrete encapsulated myomatous tumors containing glands were described. One is perplexed, however, by the apparent frequency with which these tumors were encountered at one time and their comparative rareness today. It must be realized that even in present day literature and medical terminology, adenomyoma actually means adenomyosis.

That adenomyosis is a common lesion has often been stated but its incidence varies considerably in the experience of various observers. Lewinski reports the incidence as 53.5 per cent of uteri removed at necropsy and considers adenomyosis, especially adenomyosis interna, as practically a physiological condition. Fallas and Rosenbloom collected 260 cases of endometriosis among their gynecological operations, an incidence of 1.62 per cent. Of their 260 cases, 49.6 per cent were internal endometriosis (adenomyosis). Von Geldern found that in one thousand consecutive pelvic operations at Stanford University Hospital there were 86 cases of uterine adenomyoma and 54 of other types of intrapelvic endometriosis. It may be assumed that he means adenomyosis instead of adenomyoma. Counsellor does not separate adenomyosis from endometriosis but states that, of 884 cases of the latter, the lesion was in the uterus in 69.9 per cent. Dougal makes the statement that for every one hundred "fibroids" there are 6 cases of internal and 25 of external endometriosis. Dannreuther found that of 115 cases of pelvic endometriosis, 39 were adenomyosis and 10 were adenomyoma. Dreyfuss reports an incidence of

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12.4 per cent of endometriosis and adenomyosis combined, 70 per cent of which was adenomyosis, in 1,807 uteri removed. Cross-sectional experience would seem to indicate that adenomyosis is three times as prevalent as endometriosis. Frankl (14) states that the frequency of uterine adenomyosis is 8 per cent that of myomas.

To evaluate the experiences of various authors one should know how their observations were made; if the uteri constituting the material were examined properly, systematically, and carefully; if the study was planned in advance and executed purposefully, with uniform data recorded in each case for further analysis, or whether the study was made in retrospect. An exact and proper pathological examination of each uterus is imperative. Tissue blocks must be cut perpendicular to the endometrial surface and must not be taken from the uterine cornua; failure to observe this precaution might explain the extremely high incidence of adenomyosis reported by some authors. Obviously the frequency with which the lesion is found will depend upon the number of sections examined in each case, because the diagnostic areas may be so sparsely or unevenly distributed as to be easily missed if too few sections are depended upon. A fair ratio should be maintained between the number of blocks taken for examination and the weight of the uterus. Further, one should know what criteria were employed in establishing a diagnosis of adenomyosis. By definition, adenomyosis consists of extension of the endometrium into the myometrium, but is it to be assumed that the line of demarcation between the two normally is always a sharp, even one? Are slight invaginations, so often seen, instances of adenomyosis representing edges of deeper invaginations demonstrable by serial sectioning? Where must one draw the line between the normal and the pathological? These questions and others can be answered only arbitrarily.

From various reports it is apparent that the majority of cases of adenomyosis occurs during the latter part of and somewhat beyond the period of reproductivity. The commonest decade is the fifth. Skamnakis found that in his series of cases 53.6 per cent were in the fifth decade and that 90.6 per cent occurred between the ages of 30 and 60 years. Dreyfuss stated that 96 per cent of his patients with adenomyosis were over 35 years of age, 72 per cent were over 40, and the average age was 46 years, and he pointed out that this was distinctly a disease of the second half of the generative period, many patients being postclimacteric. Of patients with endometriosis, on the other hand, he found that 30 per cent were under 30 years, 54 per cent under 35, and the average age was 33. Frankl (15), however, found that of 94 patients with adenomyosis 10 were in the fourth, 58 in the fifth, and 25 in the sixth decade, and states that "we may consider adenomyosis a disease which occurs in the preclimacteric age, never before menarche, and probably never after menopause, although it may become manifest . . . several years after the menopause."

PATHOLOGY

In uncomplicated adenomyosis the uterus is usually from slightly to greatly enlarged due to thickening of the uterine wall, chiefly the result of associated myometrial hyperplasia. This thickening is usually diffuse and symmetrical, but occasionally the enlargement is irregular and asymmetrical due to an irregular distribution of the islands of aberrant endometrium. Examination of the cut surface reveals a trabeculated whorl-like appearance and, while there are no circumscribed nodules, there are indefinite nonencapsulated areas consisting chiefly of concentrically hypertrophied myometrium about the endometrial islands. Occasionally there are cysts in the centers of these nodules which are usually but a few millimeters in diameter but which, in rare instances, are from one to several centimeters in diameter. Occasionally these cysts contain blood but usually not. In some cases there are adhesions between the uterus and other pelvic structures due to associated peritoneal endometriosis or to a serosal inflammatory reaction subsequent to subperitoneally located islands of endometrium in the uterine wall. The myometrium is generally firm, sometimes hard.

Microscopically the important feature is the abnormal presence of endometrium within the myometrium. This may be in the form of irregular islands or strands which are usually perpendicular to the endometrial surface. The inner half of the uterine wall is most frequently and more extensively involved. The endometrial glands are surrounded by cytogenic stroma which, when present ectopically without association with glands, should provide the diagnosis of adenomyosis. The cyclic menstrual changes of the normal endometrium are faithfully reproduced in the aberrant endometrium, but actual bleeding into the lumens of the glands rarely occurs (Dockerty). The absence of blood in these glands or cysts might be interpreted to mean that the glands communicate with the uterine canal and their contents are permitted to empty or drain into the canal. This communication doubtless often exists, but the absence of blood in these misplaced glands is probably due to the fact that hemorrhage into the

glands does not occur. Abnormal changes in the endometrium lining the uterine canal do not occur in adenomyosis. Invasion of the cervix by adenomyotic glands apparently does not occur.

Associated lesions. Rockstroh reported the presence of myoma of the uterus in 70 per cent of the cases of adenomyosis which he studied, Frankl (16), 30.7 per cent, and Adler, 40 per cent. In a series of 99 cases of adenomyosis Skamnakis found some type of uterine or adnexal disease in all but 8. The lesion most commonly found in association with adenomyosis was uterine myoma, which was present in 53.8 per cent of the cases. He did not record the presence of myometrial hyperplasia. Skamnakis concluded that when carcinoma of the uterus was present, the concurrence of the two lesions was merely a coincidence, even if the neoplasm was an adenocarcinoma of the corpus uteri. This agrees with Meyer's viewpoint. The complication of carcinoma of the uterus in cases of adenomyosis "interna" has been recorded by Frankl as 2.8 per cent, by Rockstroh as 2.7 per cent, and by Skamnakis as 6 per cent. Dreyfuss found myomas present in 62 of his cases of adenomyosis, myometrial hyperplasia in 44, both in 40, and atrophy of the myometrium in 7.

Witherspoon stresses the theory of estrogenic principle in etiology, believing that hormonal stimulation causes all overgrowths of endometrium and myometrium, including neoplasms. This would explain the frequent coexistence of uterine myomas, adenomyosis and both myometrial and endometrial hyperplasia.

PATHOGENESIS AND HISTOGENESIS

The following theories of origin of adenomyosis, and seemingly adenomyoma as well, have been postulated by students of the subject:

1. *Direct invasion of myometrium by endometrium.* The actual mechanism of such a phenomenon is not clear, but it may be suggested that normally the myometrium exerts a certain physiological pressure against invasion by the endometrium with which it is in direct and intimal contact, and the loss, absence, or diminution of such pressure may permit invasion or intermingling. Some such biological pressure must prevent the encroachment of epithelium and connective tissue throughout the body. Both Cullen (6) and Frankl (14) have championed the invasion theory, and apparently it has been applied with equal facility to adenomyoma, a process more difficult to understand. The stroma of the islands of adenomyosis interna is presumably derived from the mucous membrane, preparing the way for the glands which are to follow in its track (13).

2. The islands of glandular epithelium represent misplaced remnants of muellerian duct epithelium (Cullen, 6).

3. The epithelium originates from mesonephric tissue (wolffian duct) (von Recklinghausen, Pick, Pfannenstiel, and others).

4. It is the result of fetal budding of the epithelium.

5. The condition represents misplaced islands of fetal mucosa.

6. The condition results from misplacement of gland tissue.

7. It is caused by invasion of the myometrium by gland alveoli during inflammation (Chiari). This may be considered under item 1.

8. It originates from the peritoneum by further differentiation or metaplasia of mesothelium (Ivanoff, Meyer, Witherspoon, Meigs, Holmstrom).

9. Migratory or metastatic theory (Sampson, 32, in 1927). Endometrium is carried through blood and lymph vessels and becomes deposited in the myometrium (Bertner).

Holmstrom distinguishes between adenomyosis uteri *interna*, in which he believes the glandular tissue arises from the endometrium; *externa* which occurs on or beneath the serous surface from (a) endometrial transplants or (b) metaplasia from serosal cells, and a third or intermediate type arising from aberrant parts of muellerian duct.

Over a 10 year period in the Alexander Blain Hospital there were 73 cases of adenomyosis of the uterus, representing an incidence of 10.7 per cent of all uteri removed. These 73 cases were analyzed as to pathological findings.

The gland areas were diffusely distributed throughout the myometrium in 24 cases, in the inner two-thirds only in 49, and in the outer one-third only in 3. In 5 additional cases only a shallow submucous zone was involved. The subserous zone was involved in but 2 cases and in 1 of these there was serosal endometriosis. In 13 cases microscopic cysts were present. Some of these were of sufficient size to be seen upon microscopic examination if carefully looked for, but no gross cysts were present. In 2 cases the glands contained some blood. Contrary to the observations of Dockerty, the glands of the adenomyotic areas in the material examined did not undergo the same cyclic changes as did the surface epithelium. Stromal proliferation apparently did occur in the latter two-thirds of the intermenstrual cycle due to progesterone influence, but changes in the epithelial cells appeared to be negligible. The adenomyotic glands more closely resembled those of the stratum basalis and did not participate to any extent in the cyclic change.

The lumens of the adenomyotic glands in the inner third of the uterine wall invariably communicated with the surface endometrium and presumably with the uterine canal, as could be demonstrated by serial sectioning. Those in the outer wall did not.

In a distinct minority of cases there was localized hyperplasia of the myometrium about the adenomyotic areas. This in some instances produces a gross nodularity and might lead to a diagnosis of adenomyoma, although the nodules are not actually neoplastic. It is conceivable that adenomyomas could be produced in this manner.

In *Gray's Anatomy* (22) the statement is made that the weight of the normal previously pregnant uterus is 42 grams. Of 51 uteri in this series, whose weights were available, 46 weighed between 50 and 250 grams, the average being 123.25 grams.

The endometrial stroma is a somewhat embryonic type of tissue, generally considered to be connective tissue, from which the endometrial glands are presumably derived, therefore the name cytogenic stroma. These cells are recognized as being endowed with a peculiar instability. Goodall states: "The stromal cell of the ovary is a very versatile structure. It now turns out that the stromal cell of the uterus runs it a close second. It is the precursor of the glandular structures of the uterine mucosa .... In the past we have given too much attention to the glandular elements and not enough to the stromal cells."

Various differential tissue stains were employed in our series of cases to distinguish sharply between endometrial stromal cells and the nonstriped muscle cells of the myometrium. It was found that Heidenhain's modification of Mallory's aniline blue stain, which utilizes azocarmine instead of acid fuchsin, furnished the sharpest differentiation, staining both cytoplasm and nuclei of muscle cells brilliant red, and both cytoplasm and nuclei of connective tissue cells and collagen deep blue. The following features were strikingly apparent:

1. In both the normal endometrium and adenomyotic islands, the stromal cells of the endometrium and the muscle cells of the myometrium possessed identical staining reactions.

2. A gradual transition between myometrial and endometrial cells occurs.

3. A zone between the two layers exists in which it is impossible to determine if the cells belong to the myometrium or endometrium.

4. Deeper in the endometrium the shape of the cells becomes altered, the cells becoming shorter and more plump, the staining characteristics remaining the same.

5. Between the interstitial cells of the endometrium there exists a fine, delicate stroma which stains blue in contrast to the red-staining interstitial (stromal) cells. This is identical to the stroma of the normal myometrium.

6. This blue-staining, reticulum-like material is the true stroma of the endometrium.

7. The cells of the endometrium usually referred to as the interstitial cells (cytogenic stroma) are really parenchymal cells, as much so as the smooth muscle cells of the myometrium to which they are genetically related.

We wish to advance the theory that by a process of dedifferentiation or metaplasia, preferably the former, less mature but more highly specialized cells are produced, and that these cells possess the potentiality to differentiate into epithelial cells which form endometrial glands. This process is similar to the differentiation of fibroblasts into osteoblasts and chondroblasts and is consistent with the generally accepted theory that mesothelial cells of the peritoneum differentiate into endometrial stromal cells giving rise to endometriosis. Other comparable examples could easily be found.

Dedifferentiation, or loss of differentiation of cells, is commonly encountered in the field of oncology and is the mechanism by which anaplasic neoplastic cells are derived from mature cells, notably surface epithelial cells, and also is observed in neoplasms which acquire a greater degree of anaplasia. The same mechanism explains the transition from hyperplasia to neoplasia in the development of tumors. In this special situation, of course, the resultant cells are not neoplastic, but the analogy is important.

The uterine wall is composed of three layers: mucosa, muscularis, and serosa. There is no submucosa. In fact there is no sharp line of demarcation between the endometrium and myometrium, but rather the one merges gradually with the other so that it is difficult to determine exactly, at the border-line, just which cells belong to the myometrium and which to the endometrium. In many instances the zone of contact between the two layers is represented by a fairly even line, whereas in many other instances the line is normally quite uneven with shallow indentations or invaginations of endometrium into the myometrium. This often constitutes a practical difficulty in distinguishing a slight degree of adenomyosis from a normal but uneven line of contact.

The entire uterus is derived from the mesoderm, and in the uterus epithelial, connective tissue, and muscle cells have a common origin. In the urogenital tract the strict specificity of cells, which is commonly believed to characterize cells derived

from the ectoderm and entoderm, does not seem to exist. Here there is less stability as to cell type and a greater tendency for transition from one cell type to another which is well reflected in neoplasms of the uterus and ovary.

If it may be granted that a transition from myometrial to endometrial stroma cells is possible, then it seems reasonable to suppose that the tendency toward this transition is greater in that portion of the myometrium which is adjacent to the endometrium, and that the tendency decreases proportionately as the distance from the endometrium is increased. This would explain the preponderance of adenomyosis in the inner half or third of the uterine wall.

That the cells of the endometrial stroma represent a less mature type of non-striped muscle cell normally composing the myometrium is consistent with the fact that some leiomyosarcomas of the uterus are composed of cells almost identical as to size, shape and staining reaction to those normally forming the endometrial stroma.

That in adenomyosis the stromal cells are formed first and the epithelial cells second is borne out by the fact that in this lesion small islands of stromal cells are encountered which by serial sectioning can be shown to be unaccompanied by or unassociated with gland formation.

Fig. 1. Typical adenomyosis involving the inner half of the wall. The islands of endometrium in the center actually communicate with the mucosa. ×75.

EVALUATION OF STUDY

The confusion in nomenclature and the promiscuous overlapping and intermingling of distinct and separate lesions renders any attempt to evaluate the literature as to incidence and other data quite futile.

Adenomyosis has no appropriate synonym. As a pathological entity it is distinctly different from adenomyoma and endometriosis.

Whether the lesion represents a minor deviation from the physiological normal or whether it is actually a disease is debatable. Mild types are separated with difficulty, but the more advanced or severe types are obviously pathological. This can be said of many lesions.

In a strict sense, endometriosis does not involve the myometrium with the exception of the shallow subseral invasion of endometriosis of the uterine peritoneum.

The difference between adenomyosis and endometriosis is reflected in the age incidence of patients with the two diseases. In the former women in late and middle life are affected, whereas the latter is a disease of women during their most productive years. The two lesions are rarely associated and occupy distinctly different anatomic sites.

Fig. 2. Diffuse adenomyosis with cysts of microscopic size. ×66.

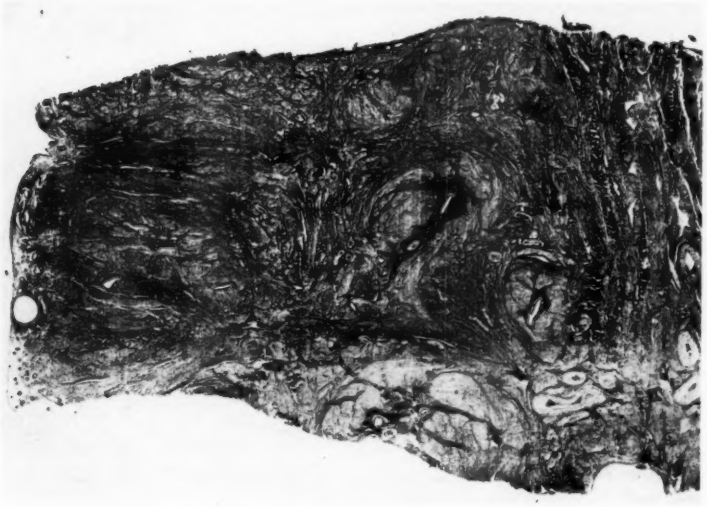

Fig. 3. Adenomyosis with atrophy of endometrium. Zone of fibromyomatous hyperplasia about the endometrial islands has been called "adenomyoma." ×75.

In adenomyosis the islands of endometrial glands are more numerous and more frequently situated in the inner half of the uterine wall and often communicate with the mucosal layer. This suggests that the mechanism of production of the lesion is direct invasion from the endometrium. This does not, however, explain the existence of islands of endometrium farther out in the uterine wall which apparently do not communicate with the mucosa. From the standpoint of histology, morphology, and embryogenesis it seems more correct to believe that the endometrial stroma (interstitial cells) is derived by a process of dedifferentiation from the myometrium. These cells may be either non-striped muscle cells or connective tissue cells, a transition from the former to the latter being not impossible in the urogenital tract. This would quite satisfactorily explain the development of endometrial islands anywhere in the uterine wall and would also account for their greater prevalence in the inner zone, inasmuch as normally the potentiality for myometrium to change into the endometrial stroma is greatest at the endometrial junction.

Some of the endometrial islands are composed only of stromal cells, a situation which approaches interstitial endometriosis described by Goodall. Such a distinction from adenomyosis is probably not warranted because whether glands are present or not is really not important, the assumption being, and probably correctly so, that the endometrial stroma (cytogenic stroma) is composed of immature cells capable of differentiation into glands. This differentiation may or may not have occurred.

The opinion has often been expressed that adenomyosis, as well as other pathological proliferations and hyperplasias of uterine tissue, are dependent upon ovarian influence. This seems to be a reasonable hypothesis, not easily contradicted, and supported by the fact that adenomyosis is often associated with hyperplasia of the myometrium and myomas of the uterus.

To a limited extent the misplaced islands of endometrium in the uterine wall undergo cyclic menstrual changes similar to those of the normal endometrium. Usually, however, the ectopic endometrium possesses a greater similarity cytogenically to the stratum basalis of the normal mucosa, participating only slightly or moderately in the typical cyclic changes.

Adenomyosis is only rarely associated with carcinoma or sarcoma of the uterus and when so, only incidentally. Adenomyosis can be definitely said not to be a potentially malignant lesion.

We believe that we have produced proof that the cytogenic stroma of the normal endometrium is derived from the non-striped muscle cells of the myometrium by a process of dedifferentiation, the cells thus produced being less mature and possessing a greater capacity or potentiality for differentiation than the cells from which they develop.

Adenomyosis is the result of spontaneous generation of endometrial stromal or interstitial cells from and within the myometrium, this tendency being greatest near the normal endometrium and decreasing toward the serosa.

The stromal or interstitial cells thus produced differentiate later to form the gland cells of the endometrium.

The so-called stromal or interstitial cells are really parenchymal cells and possess a finely distributed true stroma.

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THE RAPID PREPARATION OF EYESOCKETS

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Parktown, Johannesburg, South Africa

THE majority of war injuries requiring eye enucleation that have been admitted to Brenthurst Military Hospital have not been straightforward in that either conjunctiva or bone framework has been lost. This condition leads to an obliteration of the sulci necessary to hold an artificial eye. In order to provide a suitable socket, therefore, some form of plastic operation has to be performed.

The usual approach to this problem has usually entailed the complete removal of the conjunctiva and an Ollier-Thiersch graft replacement of the raw bed. This operation has been performed by making a mold of the desired socket in gutta-percha, covering it with a Thiersch graft, and embedding it in the socket by performing a complete tarsorrhaphy.

Two complications militate against perfect results in a fair percentage of cases: (1) the invariable tendency for graft contracture, and (2) sepsis.

The tendency for graft contracture lasts several months and because of this fact the mold has to be kept in for a considerable period, the average being about 3 months. As the contracture tension is uniformly toward the center of the mold from all directions, there is a distinct risk that the gutta-percha may burst the bonds of the tarsorrhaphy and slowly extrude from the socket. The risk is, of course, increased if sepsis intervenes; it does, in spite of all precautions, in a certain percentage of cases. It is therefore obvious that this type of case has to be under close supervision by the plastic surgeon for a period of about 3 months and sometimes longer.

From the Brenthurst Red Cross Military Hospital for Plastic Surgery.

It is the purpose of this paper to present a method of socket preparation whereby graft contracture is not a disadvantage, sepsis is controlled, and the period of hospitalization is brought down from months to days.

METHOD

The prosthesis used is a transparent acrylic the size and shape of an artificial eye. Its form can be modified as required by the addition of stent composition. The acrylic is pierced by 2 steel tubes set at an angle with the apex placed posteriorly and the divergent arms, which stand out for a distance of about ½ inch, placed anteriorly (Fig. 1).

The bed for the graft is prepared by carrying incisions from immediately behind the tarsal plates to meet at the outer and inner canthi. Thus a complete oval trough is made, the vertical depth being half the vertical height of the prosthesis.

The prosthesis is now covered by a Thiersch graft which has been split posteriorly to allow for drainage. The whole is now kept in position by performing a medium tarsorrhaphy between the divergent arms of the steel drainage tubes.

It will be noticed that the conjunctiva is not disturbed but is allowed to retract toward the back of the orbit. This area is kept free of discharge by constant saline irrigation, the fluid being introduced by a chip syringe through one of the drainage tubes, the effluent passing out through the other. The graft is, of course, not interfered with in any way.

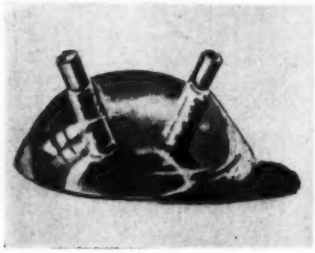

Fig. 1. The acrylic "eye."

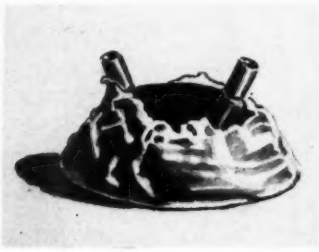

Fig. 2. Graft on acrylic.

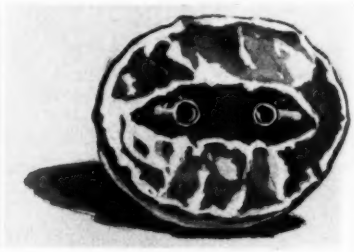

Fig. 3. Graft on acrylic.

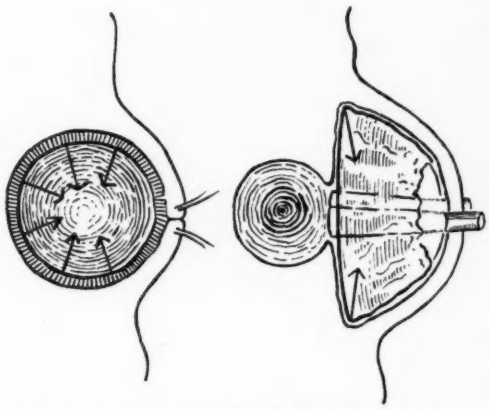

Fig. 4. Left, Tension, accomplished by the old method.
Fig. 5. Tension, accomplished by the Brenthurst method.

The graft tension in this case does not tend to close down toward the center of a sphere but toward the center of a circle; therefore the tendency is to grip the prosthesis more firmly but not to extrude it (Figs. 4 and 5).

When this procedure is followed the plastic prosthesis can be removed in 5 days, leaving a grafted socket which can immediately accommodate an artificial eye.

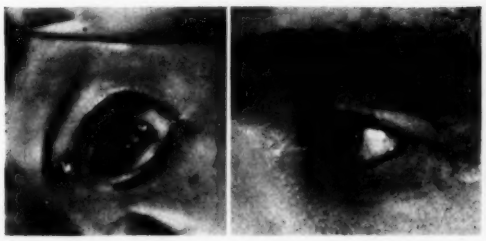

Fig. 6. Left, Photograph showing the prepared socket.
Fig. 7. Photograph showing the artificial eye in position.

After another few days of retention at the plastic center so that the patient may learn to carry out the correct orbital hygiene, he is discharged with strict injunctions that the artificial eye must be worn day and night for at least 4 months and is to be removed only for the purpose of irrigating his socket.

SUMMARY

1. A new method of eyesocket preparation is described.

2. The period of hospitalization and after care is brought down from a period of a few months to a few days.

This paper is published with the kind permission of Colonel I. W. Brebner, O. C. Brenthurst, and Brigadier Sir Edward Thornton, D.G.M.S., South African Forces.

LINITIS PLASTICA TYPE OF CARCINOMA

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Chicago, Illinois

EVER since the recognition of the "contracted" or "leather bottle stomach," and particularly since Brinton's classical description of this disease which he named "linitis plastica," an extensive literature on the nature of this lesion has accumulated. As a matter of fact, Howard, who reviewed the literature up to 1933, stated that there were 42 terms coined by various authors as the most appropriate names for this entity. The many different names given to this condition serve as an index of the multiplicity of the views held regarding this disease. Though there are still opinions in favor of a specific or nonspecific inflammation as the principal etiological agent producing linitis plastica, it seems clear that more and more evidence is being brought forward in favor of its neoplastic nature.

In the following report the results of a study of 26 instances of so called linitis plastica are given. This study was undertaken, not so much for the purpose of clarifying the concept of linitis plastica since this has been attempted often previously, but rather to see whether investigation of a large amount of autopsy material would disclose diseases other than carcinomas which sometimes cause linitis plastica. It was also thought that it might be of interest to study the metastases, whether or not the linitis plastica type of carcinoma varies from other carcinomas in the stomach as to the types and locations of metastases, and whether or not there is any difference in survival periods. Because of the fact that autopsy material was exclusively used for this study, a comparison could easily be made between the duration of the disease and autopsy findings, in patients with linitis plastica carcinoma and in patients with other carcinomas. Only the more pertinent references are given; for more complete literature see Lyle, and also Howard.

MATERIAL STUDIED

This study deals with the examination of 26 patients or records of these patients, showing, either at operation or at autopsy, linitis plastica type of carcinoma[1]. Only the surgical patients who subsequently died and came to autopsy were included in this study. The clinical records and autopsy findings of 40 patients with other forms of gastric carcinoma were studied for comparison. Since the latter were observed during the same period as the former, the relative incidence of the linitis plastica type of carcinoma, as compared with the incidence of the other types of carcinoma of the stomach, could be obtained. Two instances of linitis plastica type of carcinoma of the rectum, 1 of the descending colon close to the splenic flexure and 1 of the gall bladder, were also included in this study. At autopsy special attention was given to the field of operation for possible evidence of recurrences and to sites of metastases. In instances in which an operation was not performed careful attention was given to the involved part of the stomach. Since frequently the brain and skeleton could not be examined, metastases to these structure were noted only when obvious. Complete histological studies were made in every instance for the special purpose of establishing a clear-cut histological picture of the changes in the stomach which eventually might aid in the evaluation of the prognosis.

It is not the purpose of this communication to analyze clinically these patients with the linitis plastica type of carcinoma. Only a few data may be mentioned. Among the 26 patients, 20 were male and 6 were female. The 2 youngest were 24 and 32 years old, and the 2 oldest were 80 years of age. The early symptoms varied considerably, and it seemed that a sensation of fulness in the stomach was most commonly present. The short time interval between the onset of the symptoms and death of the patients who did not submit to surgical procedure is significant. Among 11 such patients, the longest interval was 1½ years, among 4, it was 1 year; among the others it was 8 months, 3 months, 9 weeks, 6½ weeks, 5 weeks, and 3 weeks, respectively. These patients came to the hospital in conditions which did not permit operation. Among 40 patients with miscellaneous types of carcinoma of the stomach observed during the same period, 15 died without operation. The time interval be-

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Aided by a grant from the Isaac and Kate Meyer Fund, and the Michael Reese Research Foundation.

[1]We are indebted to the surgical department for the use of the records of these patients.

tween onset of symptoms referable to gastric disorder and death of these patients was definitely longer, the longest being 3½ years. The time interval between the onset of symptoms and operation among the 15 patients with the linitis plastica type of carcinoma who were operated upon, was longer. The following periods were noted: 2 periods of 6 years each, 1 period of 5 years, 1 period of 3 years, and 1 period of 2 years. The interval among the 10 remaining patients varied from 6 months to 1 week. As compared with the control group it must be stated that in general the time interval between the onset of symptoms and recognition, and subsequent operation was definitely longer in patients with the linitis plastica type of carcinoma than this interval in patients with other forms of carcinoma of the stomach. The longest interval in the latter group was 4 years in a single instance.

The postoperative period of the 15 patients with linitis plastica type of carcinoma seems uncommonly short. This may be explained in part by the very nature of this material, since obviously only those patients were used in this study who died and on whose remains an autopsy was performed. However, it should be pointed out that the longest survival period was only 3 months. Among 11 patients, it was 11 days or less. The survival period of the 40 control patients was somewhat longer, the longest period being 18 months (2 patients), the next longest, 1 year, and the next 2, 9 months each. However, as previously stated, the fact that only autopsy material was used may explain in part the generally unfavorable outcome. Among the 15 patients with the linitis plastica type of carcinoma who were subjected to operation, 12 were found to be inoperable.

In 3 patients a linitis plastica type of carcinoma was found in the large intestine. In 2 of these patients it was located in the rectum, and in the 3d it was in the descending colon close to the splenic flexure. In a 4th patient the same type of tumor was found in the gall bladder. The patient with the primary tumor in the descending colon gave the clinical impression of having a primary carcinoma of the ovary. The ovary was removed surgically, but the patient died 2 months later of intestinal obstruction and the primary tumor in the colon was found at autopsy. The disease of the patient with the gall bladder carcinoma was diagnosed clinically as an intestinal obstruction. At autopsy it appeared that this was caused by metastases to the colon and mesentery. The diseases of the patients with the rectal lesions were diagnosed correctly.

STOMACH LESIONS AND SITE OF METASTASIS

In this study special attention was given to the stomach lesions and to the site of metastasis. Grossly, the stomach lesions appeared essentially similar in all instances, though there were marked variations in regard to the extent of the lesion. From the external appearance the stomach was contracted, the contracted regions being firm and sometimes of cartilaginous consistency, and the peritoneal surface was thickened and grayish white. The most frequently encountered site of the lesion was the pyloric region, but not necessarily the pylorus itself. Seemingly, the lesion from there extended toward the fundic portion. In 9 advanced cases practically the entire stomach was involved and was firm and contracted. Most commonly the peritoneal surfaces were smooth; occasionally protruding minute, firm nodules were recognized beneath the peritoneal surface. Thickened, whitish vessels were also observed in this area. Rarely was the stomach adherent to the pancreas. In one instance, however, the tumor had actually extended into the pancreas. The omentum was often involved, shrunken, and plastered to the stomach. When the stomach was opened, the involved portions were cut with markedly increased difficulty and a gritty sensation was felt. On casual gross inspection of the mucosa no tumor was recognized, and only the palpating finger in the pyloric region met, in early cases, areas of greater density within the mucosa where it could not be lifted from the underlying submucosa with a forceps. Yet, no tumor was visible to the naked eye. The mucosa was thickened, usually reddish gray or slate gray. On close inspection the cobblestone architecture of the mucosa was absent, and the mucosa appeared much drier than normal.

A very superficial ulcer was commonly encountered in patients like the one just mentioned. Invariably there was a stenosis of some degree of the lumen of the stomach in the pyloric region. In the more advanced cases, most of the stomach mucosa was involved, the mucosa being firmly attached to the submucosa, and the latter to the musculature. The rugae were sometimes absent, but in other instances they were swollen, comparable to cerebral gyri in contour, firm and rigid, and densely adherent to the submucosa. In some instances, when only a part of the stomach was involved, cordlike, firm projections extended from the primary pyloric lesion into the submucosa of the adjacent prepyloric and fundic portions. When most of the stomach was involved, several ulcers were present; in one instance 8 small, superficial ulcers were recog-

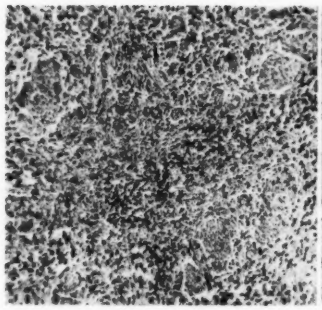

Fig. 1.

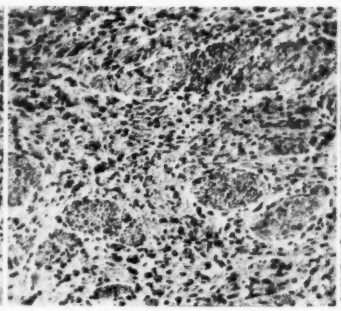

Fig. 2.

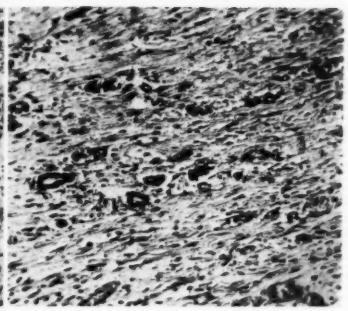

Fig. 3.

Fig. 1. Note the presence of many nuclei resembling those of large lymphocytes. (Iron hemotoxylin-eosin preparation, ×55.)

Fig. 2. Field similar to that shown in Figure 1. The large dark nuclei are obviously nuclei of tumor cells. (Iron hemotoxylin-eosin preparation, ×105.)

Fig. 3. Note the miniature glandular structures. (Iron hemotoxylin-eosin preparation, × 80.)

nized throughout the mucosa. On section the wall of the stomach was found to be greatly thickened. Cross sections often measured 1.5 to 2 centimeters. The lesion often extended in the form of whitish filaments into the muscularis, the filaments actually forming a rough network which again was crossed by fine interlacing fibers which often produced a bizarre architecture with the uninvolved musculature presenting pinkish, glistening inclusions.

The histological elements in the sections of the stomach varied widely. However, when enough sections were studied, it became clear that similar elements were present in every instance. These were encountered so consistently that it had to be conceded that, from the histological picture alone—without reference to the gross observation—the correct diagnosis could be established. Most of the sections showed, as the outstanding lesion, a new formation of connective tissue fibers which often were hyalinized, and extended throughout the entire wall of the stomach and often traversed the muscularis. Along the fibers, cells characteristic of chronic inflammation were often abundant. Large endothelial leucocytes seemed to be the most frequently encountered type of cell. Many lymphocytes and eosinophilic leucocytes were constantly present and plasma cells were common. Polymorphonuclear leucocytes were relatively rare, though in the vicinity of superficial ulcers they were quite frequent. It must be pointed out that lymphocytes were often in a perivascular position. The arteries, particularly the larger ones, showed varying degrees of intimal

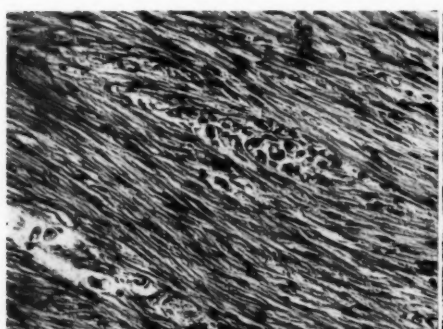

Fig. 4.

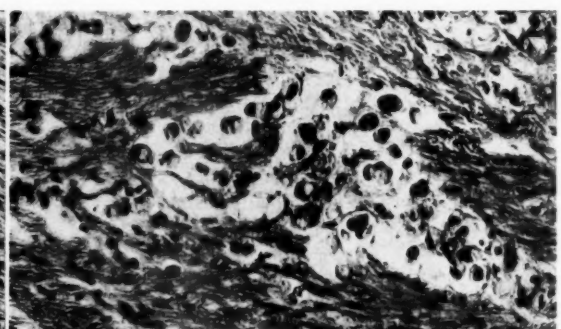

Fig. 5.

Fig. 4. Note signet ring shaped tumor cells and dark nuclei of other tumor cells; also marked new formation of connective tissue. (Iron hemotoxylin-eosin preparation, × 125.)

Fig. 5. Note the signet ring shaped tumor cells and darkly stained nuclei of tumor cells. (Iron hemotoxylin-eosin preparation, × 180.)

thickening, but endarteritic changes were not encountered. The changes so far described were most commonly found, whereas the changes to be subsequently described, though eventually observed in every instance, had to be searched for, and often many blocks had to be examined before they were visualized. Small cells with little recognizable cytoplasm, and nuclei about the size of the nuclei of endothelial leucocytes were noted; sometimes they were arranged in clumps, sometimes they followed the course of connective tissue fibers, but more often they were isolated or in small groups along the interstitial tissue within the muscularis. These nuclei were dark, irregularly outlined and often seemingly in a state of pyknosis. However, their shape was not round, being either elongated, oval, club-shaped, irregular, or thickened at both poles. When thin sections were examined, atypical mitoses were frequently seen. These cells often plugged small lymphatics. From their appearance and their invasive properties, they readily could be classed as malignant tumor cells.

Besides the darkly stained tumor cells, there also were somewhat larger, definitely epithelium-like tumor cells which were isolated, intermingled with either the dark tumor cells or the endothelial leucocytes, or in loosely clustered small groups. These cells showed all transitions between low cuboidal cells similar to those to be described subsequently and typical signet ring-shaped cells. In the nonsecreting stage they had polyhedral, slightly basophilic cytoplasm, and well rounded nuclei which varied in size and shape. These nuclei were rarely found in the state of mitosis, and were situated at the base of the cell. Other apparently similar cells had minute, clear spaces or one large "empty" globule within the cytoplasm while in others the entire cytoplasm seemed clear. Often only the cell membranes were recognized. The nuclei in these cells were small, dark, compressed, and crescent-shaped.

A 3d type of tumor structure encountered, also only after a number of sections were carefully scrutinized, consisted of minute glandular or acinar structures lined by one layer of rather low cuboidal cells. These structures may be termed "miniature glandular structures." Their lining cells showed all the features of malignant cells. Often it seemed that some of these cells had lost their connection with the acini and, either singly or in isolated small groups, had invaded the surrounding tissues. These miniature glandular structures were more commonly found in early, still localized lesions than in advanced tumors. Sometimes in these early instances, many small glandular structures were observed interrupting the course of normal sized and normal appearing submucous glands in the pyloric region. These miniature glandular structures had disrupted the orderly arrangement of the submucous glands and in a few foci had invaded the mucosa.

The metastases often showed the carcinomatous nature of the lesions more obviously. Usually 1 of the 3 malignant elements predominated.

Sections which were taken from the rectal and gall bladder lesions of the patients mentioned showed lesions identical to those just described in the stomach.

SUMMARY OF GROSS AND HISTOLOGICAL FINDINGS

We may state that the stomach grossly may be involved diffusely, or in a more or less localized area within the pyloric region. The stomach is contracted, firm, often of cartilaginous consistency, and greatly thickened. An outspoken tumor is sometimes not recognizable on cursory examination, but closer study shows the absence of the normal contour, the immobility of the mucosa and dense fibrous streaks extending throughout the entire thickness of the stomach wall. Histologically the lesion is characterized by subacute and chronic inflammation with much fibrosis and hyalinization, by the presence of small darkly stained tumor cells, small epithelial cells of low cuboidal shape with transitions to typical signet ring shaped cells, and miniature glandular structures. These 3 tumor elements may be difficult to find but they can be demonstrated in every case if searched for. Any one of these tumor structures may predominate.

Metastases involved the peritoneum and the omentum most frequently; next in frequency was the involvement of the peritoneal lymph nodes. The intestinal tract was the seat of metastasis 5 times. Among the 6 female patients the ovaries were involved 3 times. The rectovesical space showed metastasis in 3 other patients, 2 males and 1 female. The spleen was involved twice. It is of interest that the liver was the seat of metastasis only 3 times. Among the 40 patients with the miscellaneous types of carcinoma of the stomach, the liver was involved 19 times. There were 6 females among these 40 patients. In only 1 of these were metastases found in the ovaries.

Neither of the patients with the rectal tumors had metastases. The female patient with the primary tumor in the descending colon had metastases to the peritoneum, peritoneal lymph nodes, ovaries, and rectovesical pouch. The patient with the gall bladder carcinoma of the linitis

plastica type had metastases to the peritoneum, peritoneal and retroperitoneal lymph nodes, liver, pancreas, colon, diaphragm, lungs, and pleurae.

EVALUATION OF STUDY

The gross and microscopic studies of these cases left no doubt that the principal lesion in the stomach, in every instance, was a diffusely infiltrating carcinoma, with marked subacute and chronic inflammation and subsequent diffuse fibrosis. It is clear that grossly and in a number of microscopic sections this lesion corresponded closely to the lesion named linitis plastica. However, it must be remembered that—as Ewing pointed out—Brinton, who coined the term "linitis plastica," was by no means certain that the process was not cancerous. Ever since Brinton, and even before him (see Howard for an extensive review of the literature), the question was often raised as to whether linitis plastica was an inflammatory lesion or a tumorous one. This controversy became quite apparent as late as 1927 when the various views were aired at the meeting of the German Pathological Society.[1] More recently an inflammatory origin of linitis plastica was strongly emphasized by Oselladore who claimed also that he was able to produce in dogs experimental lesions indistinguishable from linitis plastica, in the sense of inflammation, by injection of diluted silver nitrate solution into the stomach. Saltykow, also more recently, described instances of contracted stomach as the result of healed phlegmonous inflammation, and Surren stressed that nothing suggestive of carcinoma could be found in the patient observed by him.

From the foregoing information it is evident that there are recently recorded instances of inflammatory lesions of linitis plastica type. Yet, combing the records of autopsy and surgical material, comprising 6,520 autopsies, we did not find a single instance of linitis plastica of the inflammatory type or a contracted stomach in which, sometimes only after extensive search, tumor cells were not demonstrable. There are, of course, instances of disease in infants diagnosed clinically as pyloric stenosis which at autopsy showed hypertrophy of the pyloric muscle without any evidence of tumor. But neither grossly nor histologically can these instances be confused with linitis plastica. Among the autopsies mentioned there was a single case which was interpreted as syphilis of the stomach. However, the lesions were not diffuse, but localized in the fundic region and close to the cardiac end. There were typical scars and large accumulations of lymphocytes around smaller arteries which showed endarteritic changes. Besides, there were gummas in the left lobe of the liver to one of which the stomach was adherent. Neither grossly nor histologically could these lesions be confused with a linitis plastica type of carcinoma. The localized character of syphilis in the stomach has been stressed previously by Fahr.

Dark cells without recognizable cytoplasm and hyperchromatic, irregular nuclei are of importance since they resemble inflammatory cells and often constitute, in many sections, the only atypical cells. From a review of reported cases of linitis plastica of both the cancer and the inflammatory type, it is evident that these cells have often been encountered. Vier stressed the findings of occasional collections of darkly stained cells which were diagnosed as "probably tumor cells." Ewing who believed that linitis plastica is a peculiar form of gastric carcinoma—the sclerosing, pyloric, and diffuse fibrocarcinoma—emphasized that disregard of the fact that epithelial cells in this type of cancer may be reduced to a minimum or may largely disappear, had led to belief in the existence of supposed benign cirrhosis of the pyloric region of the entire stomach. On microscopic examination Ewing found cells with hyperchromatic nuclei, and isolated cells with mucous globules as well as single rows of cells resembling plasma cells in the fibrous tissue. He concluded that all cases of hypertrophic pyloric stenosis and diffuse cirrhosis of the stomach in adults are atypical fibrocarcinomas. The results of our study are in agreement with Ewing.

Histological findings. The histological findings in these cancers warrant their classification as a special entity. Though "scirrhous" cancer is often used as a synonym for linitis plastica type of cancer, it must be emphasized that "scirrhous" simply implies the firm consistency of the tumor. "Scirrhous" carcinoma, by definition, is more likely to be a carcinoma simplex with narrow cords and bands of cells, rich in collagenous fibers. There can be no question that such a scirrhous carcinoma exists in the stomach, but from the foregoing material it is clear that the linitis plastica type of carcinoma is strictly a different entity.

From the histological study it is apparent that this carcinoma is originally an adenocarcinoma, with the production of mucin by some of the individual cells. As has been pointed out by one of us (19) in a study of mucinous carcinoma of the mammary gland, there are 2 principal types of mucinous adenocarcinoma: one—the true mucinous carcinoma, in which the mucinous material

[1] Verh. Deut. path. Ges., 1927, 22: 93.

fills the glandular structures and the lining tumor cells may either not be recognizable at all or be present singly or in small groups; the other—the signet ring cell mucinous carcinoma, characterized by well preserved mucin secreting cells with basophilic or clear cytoplasm and crescent shaped, compressed nuclei situated at the base of the cell. Signet ring shaped tumor cells were present in every case in this series. Similar cells were also present in many instances of linitis plastica type of carcinoma described in the literature, particularly those studies done more recently by Dixon and Stevens, Chiray and Albot, Monserrat, Premoli, and Riveros. Thus, it seems that the linitis plastica type of carcinoma is primarily an adenocarcinoma in which individual glandular structures are present in diminutive sizes, the individual cells early breaking loose from the acini, but still retaining their ability to produce mucin. The 3d type of tumor cell characterized by the presence of hyperchromatic, irregularly shaped nuclei, may be explained by the assumption that after the individual mucin secreting lining cells have become separated from the acini over a certain period of time, they stop producing mucin and the nuclei assume the bizarre form, whereas the cytoplasm is retracted around the nuclei and thus becomes hardly visible.

There are instances of signet ring cell types of mucinous carcinoma of the breast on record, in which the tumor had produced a number of metastases, particularly in the ovaries. Jørgensen termed his type of breast tumor "cancer of the breast with metastases resembling linitis plastica." There was metastasis to the rectovaginal septum. Among the 26 cases in this series, there were 6 females, 3 of whom had metastases to the ovaries and a 4th had metastasis to the pouch of Douglas. Among the 40 control patients showing various other types of gastric cancer, there were also 6 females of whom only 1 had metastasis to the ovary. From this relatively small series, and from certain somewhat similar tumors in other organs, it seems that a tumor containing signet ring shaped tumor cells is more likely to produce metastasis in the ovary than are other tumors. Monserrat very recently again drew attention to the ovaries as sites of metastases from a linitis plastica type of carcinoma of the stomach.

Clinical findings. From the clinical point of view the linitis plastica type of carcinoma also seems to behave somewhat differently from other gastric cancers. Clinical symptoms appear late and when patients reach the operating table, a laparotomy often shows an immovable stomach with peritoneal metastases. It is also noteworthy that the longest survival period following operation was only 3 months, and that among 11 patients it was 11 days or less. This short survival period definitely indicates that these patients were submitted to the surgical procedure as the last resort. Eight of these 11 patients were found to be inoperable on exploration; 5 of these 11 patients died from bronchopneumonia, while 3 showed abscess formations. The pneumonia was obviously an aspiration pneumonia. It seems that because of some obstruction and regurgitation of food, these patients developed aspiration pneumonia and, some of them at least, were operated upon because of intestinal obstruction while they had the pneumonia. This fact may also explain their rapid deaths. Unlike other gastric cancers, the linitis plastica type does not produce a single tumor which causes obstruction or is readily diagnosed by roentgen examination, but produces a diffuse lesion in the stomach. This may explain why the symptoms appear late in the course of the disease.

That linitis plastica type of carcinoma of the stomach constitutes a special form of carcinoma may also be indicated by its metastases. In only 3 out of 26 instances was the liver involved, while in the control group of 40 miscellaneous gastric cancers, the liver showed metastases 19 times. In 7 of the 26 patients with linitis plastica carcinoma, no metastases were encountered, while 8 patients of the control group were free from metastases.

Of the 7 patients without metastases, 4 were operated upon, but the tumor was found to be inoperable. Yet at autopsy no metastasis was encountered. Two of the other 7 patients were not subjected to surgery because their conditions were considered to be too weak. The 7th patient, 80 years old, was not operated upon because of her age. Among the 8 patients of the control group who were found to be free from metastases, 4 were operated upon and a partial gastrectomy was performed. A 5th was found to have an inoperable tumor. In 2 other patients of these 8 the gastric carcinoma had not been diagnosed clinically, and in the last instance, the patient was too anemic to be subjected to operation. In short, among 9 patients with gastric carcinoma and no metastases who were subjected to operation, all with linitis plastica type of carcinoma on exploration were declared inoperable (4 instances) as compared with only 1 patient of the miscellaneous cancer group (5 instances). Thus, it is evident that in some cases the linitis plastica type of carcinoma must have been present for a considerable time, and that extensive involvement of the stom-

ach renders the tumor inoperable, yet no metastasis is found at autopsy.

The 2 patients, 1 male and 1 female, with linitis plastica type of carcinoma of the rectum showed no metastasis at autopsy. There was nothing unusual in their clinical course. In 1 instance the diagnosis was made from a biopsy specimen. The patient with the carcinoma in the descending colon showed metastases to the ovaries, omentum, and peritoneal lymph nodes. As stated previously, the patient with this type of primary carcinoma in the gall bladder showed diffuse metastases.

It is noteworthy that in 5 of these 26 patients, metastases were found in the intestinal tract. They were present in the transverse colon in 4 instances and in the descending colon in 1. They were recognized as metastatic lesions because they were smaller than the primary lesion in the stomach, and they had involved the peritoneal surface principally, though the muscularis and submucosa were also involved. In 2 instances the mucosa was also invaded by the tumor. Besides, the involvement of the omentum and adhesions of the latter to the stomach indicated the primary site in this organ. However, in 1 instance the colon was the only site of metastasis. Such observations have been made previously. Judd, Larsen, and Tilden reported an instance of apparent metastatic carcinoma of the linitis plastica type. The stomach had been removed some time previously. Gormsen found constricting rectal metastasis in his patient, and Dixon and Stevens reported 6 instances of metastasis in the intestinal tract. Sussman's report also should be mentioned here. These observations are important since at operation such lesions might be considered primary tumors.

As stated before, in addition to the presence of tumor cells and subacute and chronic inflammation, these tumors are characterized by much fibrous connective tissue with hyalinization. The latter is occasionally explained by the simultaneous presence of chronic passive hyperemia. As a matter of fact, chronic passive hyperemia alone has been considered a cause of so called linitis plastica (Sury). Today it is obvious that chronic passive hyperemia plays no rôle either in the production of linitis plastica type of carcinoma or in the causation of a supposedly nonspecific "cirrhosis" of the stomach, since this condition is never encountered in instances of uncomplicated heart failure of long duration which show severe chronic passive hyperemia in all the organs. However, it seems possible to link the fibrosis of the stomach in these instances with end-stages of so called serous gastritis. Eppinger, Kaunitz, and Popper defined a condition in the tissues as serous inflammation produced by the presence of plasma outside the capillary wall. In the acute stage, there are hardly any cellular elements forming the inflammatory exudate; but there is principally an edema-like, or serous exudate. The significance of the concept of serous inflammation lies in the fact that, as the authors stated, the plasma outside the capillaries eventually stimulates a connective tissue overgrowth. Instances of severe fibrosis or sclerosis in other organs have been attributed to serous inflammation (Rössle). It may be of interest to note in this connection that as early as 1910 Krompecher referred to a relationship between edema and sclerosis in the stomach. In the linitis plastica type of carcinoma, with diffuse infiltration of tumor cells throughout the wall, a stasis within the lymphatics is likely to occur. It is often observed that the darkly stained tumor cells plug a number of lymphatics. Thus, it is possible to attribute the extensive fibrosis of the stomach in these patients to the presence of plasma outside the vessel wall and to diagnose the resulting fibrosis as a sequela to so called serous inflammation.

As far as nomenclature is concerned, it is evident that the "linitis plastica type of carcinoma" is cumbersome but that it has the advantage of usage. Besides, "linitis plastica" seems to describe the gross appearance of the lesion quite adequately. The term linitis plastica alone should be discarded since the existence of a nonspecific inflammatory lesion such as this term denotes is very questionable. If diffuse inflammatory lesions caused by syphilis do exist—which we doubt—they may be so designated. However, by using "linitis plastica" as a descriptive term, adding the fact that the lesion is cancerous as—"linitis plastica type of carcinoma"—there seems no serious objection to this term.

SUMMARY

Twenty-six instances of linitis plastica type of carcinoma of the stomach, 3 of the large intestine, and 1 of the gall bladder are reported. The time interval between the onset of symptoms referable to gastric disorders and death in patients with linitis plastica type of carcinoma was uncommonly short as compared to that of a control group of patients with miscellaneous gastric carcinomas. Also the postoperative survival period of the 15 patients who were operated upon seemed very short. Among 11 such patients, the survival period was 11 days or less. Among 9

patients with gastric carcinoma and no metastases who were subjected to operation, all with the linitis plastica type of carcinoma on exploration were inoperable (4 instances) as compared to only 1 patient of the miscellaneous group (5 cases).

Grossly, and particularly histologically, the linitis plastica type of carcinoma must be differentiated from other types of carcinoma. It is characterized histologically by subacute and chronic inflammation with much fibrosis and hyalinization; by the presence of small darkly stained cells with little cytoplasm, of small cells of low cuboidal shape with transitions to typical signet ring-shaped cells; and by miniature glandular structures. Metastasis in the liver was found only 3 times, whereas among the 40 miscellaneous types of carcinoma of the stomach the liver was involved 19 times. Among 6 females, the ovaries showed metastases 3 times, whereas among 6 females of the miscellaneous group the ovaries were involved only once.

It is very questionable whether linitis plastica, in the sense of a purely inflammatory lesion, exists. Among 6,520 autopsies there was not a single instance observed. The only chronic inflammatory lesion in the stomach, in this group, was diagnosed as the result of syphilis. The chronic inflammatory changes in the stomach in instances of the linitis plastica type of carcinoma with severe fibrosis may be explained on the basis of early, so called, serous inflammation and resulting overgrowth of connective tissue as it is known to occur in other organs.

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TOTAL ABDOMINAL HYSTERECTOMY

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THE operation of *complete* hysterectomy is being performed with increasing frequency in the treatment of lesions involving the uterus. With many surgeons practically all hysterectomies are of the total variety. Many arguments in favor of the procedure have been advanced; some have been raised in opposition. However, all phases of the question considered, a carefully planned technique and the operation performed by a skilled surgeon, the mortality and morbidity of total hysterectomy are no greater than those in subtotal hysterectomy and the results which are obtained, in many respects, are better.

Many methods for total removal of the uterus have been described. In our own country, Masson (6), Farrar (4), and Richardson (14) have described excellent procedures. During the past few years the senior author has attempted to better his own technique and believes that he has succeeded in simplifying and improving the operation. He has been aided by several instruments of his own designing and now feels that the operation has been sufficiently perfected to warrant its presentation. Of a total of 966 hysterectomies the senior writer has performed, this technique has been followed in 156 consecutive cases. During the past 18 months practically all of our hysterectomies have been carried out by this method. Only in cases of extremely stout patients or when, for some reason, the operation presents unusual technical difficulties or it is felt that the individual might be endangered by having the cervix removed, is it carried out routinely, whether the process be benign or malignant.

It is not the purpose of this paper to present extensively the arguments for or against total hysterectomy. Innumerable articles have appeared dealing with the problem, 98 contributions on the subject having been incorporated in our American literature within the past 8 years. The consensus seems to be that total hysterectomy possesses definite advantages over the subtotal operation and that, in competent hands, it is attended by as low mortality and morbidity rates as the supravaginal operation. This thesis, well supported by extensive statistical analyses, has been presented many times. It is endorsed by the present writers.

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THE CERVIX AS A MENACE

The main advantage of the total operation is that the cervix, the site of infection or, possibly, neoplasm, is removed. It is the chief and, probably, the only point in its favor. The question arises as to whether or not the advantage of eliminating the cervix outweighs the disadvantage of slightly increased mortality and morbidity. Clearly, the complete operation requires more skill; yet in clinics where the work is handled by experts, there is apparently no appreciable difference in mortality or morbidity. What this difference may be in the innumerable small hospitals, where, as a sum total, most hysterectomies are probably performed, one cannot say.

It is clear, however, that if one advocates the complete operation, one must first be convinced that the retained cervix is a definite liability and to what degree this is true. Even more important, one must be sure one possesses the necessary skill for the safe and proper performance of the more formidable operation.

PROS AND CONS

Richardson (13), comparing total with subtotal hysterectomies, offers certain arguments in favor of the complete procedure. He states that the incidence of cervical stump carcinomas at Johns Hopkins, among 940 patients having cervical carcinoma, was 2.3 per cent. He stresses the prevalence of infection in the retained cervix and mentions that, with the proper technique, the difference in mortality between the two operations is so slight as to be negligible. He concludes, "Consequently, despite its many alleged advantages, conservative subtotal hysterectomy has to-day only a limited field of applications." After considering the possible disadvantages of the complete operation, Richardson states that it may be accompanied by a higher incidence of postoperative hemorrhage, shock, and damage to the bladder, ureters, and rectum, with subsequent fistula formation, cystitis, pelvic cellulitis, wound infection, phlebitis, and thrombitis. He indicates, however, that these are no more common in the total operation, if it is *expertly* performed. He emphasizes the fact that the operation is one requiring greater experience and surgical ability than is called for in the supracervical operation. Richardson, who formerly favored the more conservative proce-

dure, now prefers total hysterectomy and states that, while occasionally the supracervical operation should be performed, it should be performed only under the following conditions: first, when there is a normal cervix; second, when there is a need for rapid conservative surgery as, for instance, when the patient is an especially poor operative risk. He makes the point that cauterization or conization of the remaining stump, following supravaginal hysterectomy, is of little or no value as compared with complete removal.

Most surgeons accept the proposition that neither the total nor the subtotal operation should be recommended as a *routine* procedure. Frequently, an occasion arises when one or the other, especially the less extensive, is clearly indicated, for example, when the patient is an extremely poor risk and the lesion benign. It seems clear that the total operation would be generally preferred were it not that it takes longer to perform; that it requires greater skill; and that, as is revealed from accumulated figures from unselected clinics, it is accompanied by higher morbidity and mortality.

In the most recent contribution on the subject from the Mayo Clinic, McKinnon and Counseller report an experience with 1920 total hysterectomies performed in the 5 year period between 1935 and 1939. It is the belief of these writers "that every patient presenting a diseased cervix in association with other uterine conditions requiring hysterectomy, should have a *total* hysterectomy." They stress the advantage of eliminating the cervical stump which may become chronically infected or, ultimately, involved in carcinoma, and they point out that following this operation there is much better vaginal support than with the supravaginal type of procedure. Among possible complications they mention postoperative hemorrhage as occurring in 8 of their cases. They admit that pulmonary embolism is more common than is the case following subtotal hysterectomy; yet the incidence of thrombophlebitis seemed higher after subtotal than after total hysterectomy. On the other hand, they found the incidence of urinary complications, following total, somewhat higher than following subtotal. The number of convalescent days was slightly greater with patients submitting to a total, while there was "about a half a day" extension of elevated temperature. The mortality rate was commendably low, being 0.78 per cent for their total hysterectomies as against 1.4 per cent for the subtotal operations. These authors point out that, when a fatality ensues, peritonitis still remains the chief cause of death. Thirteen of the 23 hospital deaths were due to this complication, while 4 were traceable to pulmonary embolism and 2 to bronchopneumonia. In the presence of pelvic infection, they point out that mortality is definitely higher following total hysterectomy than following subtotal: hence, with this group, the operation of choice should be subtotal hysterectomy. Their conclusions are that the advantages of removal of the cervix far outweigh any known complication that may arise following total hysterectomy and, that except in cases in which there is known pelvic infection, total hysterectomy should always be the operation of choice.

In Masson's (6) latest contribution he expresses himself as more convinced than ever concerning the utility of the total operation and he again emphasizes that "the end-results are better, the morbidity less, and the mortality no greater than when a subtotal abdominal hysterectomy is done." Furthermore, he makes the statement, the truth which most of us will accept, that "for the occasional operator, or for one who has not yet taken special pains to become familiar with the technique of total abdominal hysterectomy, it is better to adhere to the subtotal operation, even the risk of leaving an infected cervix."

Masson refutes the claim that total abdominal operation is a frequent cause of dyspareunia. When such a condition is found, it is not the result, he states, of the operation as much as it is of the fact that the operation has been improperly performed. Fixation of the ovaries in the vault of the vagina is, he suggests, a common cause of this complication. Masson (6) reports that of a group of 1776 cases in which the total procedure was carried out at the Mayo Clinic, the mortality was 1.2 per cent. In a later series he reports a mortality as low as 0.76 per cent. Masson invariably removes the tubes in all hysterectomies. When the ovary is saved, he prefers to bury it between the folds of the broad ligaments well up on the side of the pelvis rather than to fix it in vault of vagina.

CARCINOMA OF THE CERVICAL STUMP

Since Chrobak of Vienna reported the first case of carcinoma in the cervical stump in 1896, 169 cases had been recorded in Germany up to 1925. As early as 1921 Polak was able to collect 256 cases from the American literature alone.

Meigs reported 1218 cases of carcinoma of the cervix seen in two Massachusetts Hospitals, with an incidence of 2.13 per cent originating in cervical stumps. Von Graff found that of 4,269 cases of carcinoma of the cervix, 4.1 per cent were stump cancers. The percentage usually given is between 2 and 6. Perhaps 3 or 4 per cent is close to the actual figure.

At the Mayo Clinic, among 1181 cases of carcinoma of the cervix observed over a short period of time, there were 47 cases or 3.97 per cent, of carcinoma of the cervical stump. The following is an illustration of the gravity of late development of carcinoma in retained cervices. Of 65 patients who were treated for carcinoma of the cervical stump at the Mayo Clinic and whom he was able to trace thereafter, Masson (6) found but 20 per cent living at the end of 5 years. From January, 1910, to January, 1937, the Mayo Clinic had 146 cases of carcinoma of the cervix following subtotal hysterectomies.

Masson disagrees with those who feel that the cervix can be adequately treated, either before or after a subtotal hysterectomy, by various procedures; such as, trachelorrhaphy, cauterization, or low amputation. Von Graff reports 37 cases of carcinoma developing in cervical stumps following partial hysterectomy, even after the cervix had been cauterized, or coned out, at the time of the hysterectomy.

Farrar (5) points out that all recent reports give increasingly larger percentages of cancers developing in the stumps of cervices left after subtotal hysterectomy. All persons interested in this subject should become familiar with the paper by this author, in which she presents a painstaking study of conditions existing in the cervix following 510 consecutive total abdominal hysterectomies. As set forth in this communication, it is reasonable to believe "that a growth hormone that has effectually stimulated the development of myomas in the corpus, may also cause profound changes in the cervix and that after the removal of the corpus by subtotal hysterectomy, the same hormones may continue to produce alterations in the cervix which eventually may be favorable to the development of cancer." Farrar notes that at the Women's Hospital in New York "seven to eight per cent" of all cases of cancer of the cervix occurred in cervical stumps. The most significant conclusion arrived at in Farrar's paper is worth quoting in full:

> "Carcinoma of both corpus and cervix uteri is more frequent in myomatous uteri. The repeated occurrence of glandular hyperplasia and cystic degeneration in the cervix when myomas are present in the body of the uterus would seem to point to a common stimulus affecting the tissues in both corpus and cervix and make it advisable to remove the uterus as a whole rather than leave the lower portion *in situ* subject to still further stimulation and the danger of infection, local or systemic, the formation of polyp or cervical myoma and the possibility of carcinoma developing in the stump."

In a discussion of the subject Scott states that in a series of 491 cases of cancer of the cervix observed at the Toronto General Hospital, there were 20 in which cancer had formed in retained cervices.

Masson (6) tells us that, at the Mayo Clinic, while they reported 164 cases of carcinoma originating in cervical stumps, they had also examined 500 other patients who were supposed to have cancer in the cervix, following a previous supravaginal hysterectomy; yet in all these cases only a benign condition was found. However, with about one-half of these patients extensive inflammatory or infective processes necessitated excision of the cervix.

MORBIDITY AND MORTALITY OF TOTAL HYSTERECTOMY

Bryan and Trabue, in a study covering many operations performed by a large number of surgeons, found a mortality of 2.73 per cent in 21,000 subtotal operations compared with a mortality of 3.28 per cent in 8,442 total hysterectomies.

Tyrone, reporting from a smaller series, gave a mortality of 1.9 per cent for 316 subtotal hysterectomies as against 2.2 per cent for 137 total operations. The author stated that the difference in time required for these different procedures was slight, not averaging "over five minutes."

McDonald strongly advocates total hysterectomy as a routine procedure in benign as well as malignant conditions of the uterus. In one hospital he reports 2628 consecutive total operations, performed by 10 surgeons, with a mortality of 1.02 per cent. He observes that the operation requires but a little more time than the subtotal procedure; to support his findings he quotes Faulkner, whose studies in anesthesia time show that but 6 minutes more are required, and he also cites Goodall who gives the additional time as 5, "never more than fifteen minutes."

In 1937 Masson (7) presented a large series of hysterectomies performed at the Mayo Clinic together with an analysis of the questions of morbidity and mortality and length of hospital stay. Included in the report were 952 total abdominal hysterectomies showing an average period of hospital convalescence of 16.5 days and a 1.4 per cent mortality. There were 451 subtotal hysterectomies with an average hospital stay of 16.2 days and a 1.3 per cent mortality. There were 322 vaginal hysterectomies with 18.4 hospital days and a 1.9 per cent mortality. The figures are revealing and coming from a well organized clinic where the operations have been performed by men of great skill, clearly demonstrate that in capable hands, there is only a negligible difference between the mortality and morbidity rates in all three

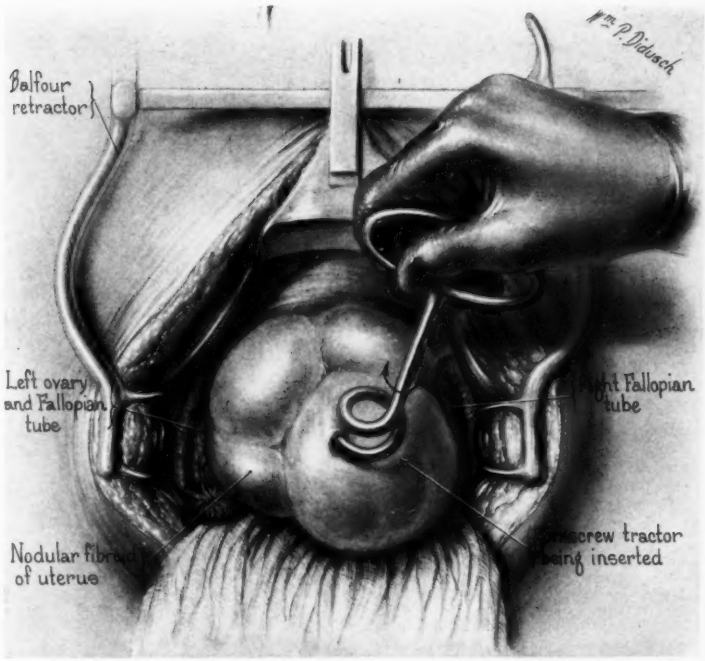

Fig. 1. Through a vertical midline incision between the pubis and umbilicus a Balfour retractor is inserted and the tumor raised into the wound by any suitable means. A corkscrew type of retractor is helpful with myomatous types of neoplasms.

types of procedures utilized in the removal of the uterus.

One of the most informative studies made of the question of mortality and morbidity rates is that of Read and Bell. In this investigation over 2,000 consecutive operations performed at the Chelsea Hospital for Women by 14 English surgeons are analyzed. In 1,700, or 70 per cent, supravaginal operations were performed while in 605, or 25 per cent, total abdominal hysterectomies were done. Under the heading of "morbidity" the authors include all patients whose stay in the hospital, following the operation, exceeded 21 days. From the study it was found that the "morbidity" rate was 20 per cent for the subtotal group, with a mortality of 2.1 per cent; while for the total hysterectomy group, "morbidity" was 27 per cent and mortality 3.1 per cent. An examination of these statistics demonstrates that, at least in the cases of these patients, operated upon by a number of surgeons, convalescence was more prolonged following the total than it was after the subtotal operations; while the mortality rate was higher by about 1 per cent. Abdominal wall rupture occurred twice as frequently after the total operation as it did after the subtotal procedure.

Many authorities claim that dyspareunia is a frequent complication following total hysterectomy. However, others believe that it rarely, if ever, occurs provided the operation is properly performed. The latter attitude is taken by Masson, Haney, and many others.

In discussing the possible dangers of total hysterectomy, Eddy and Miller reviewed the cystoscopic findings of 200 patients on whom total hysterectomies had been performed. Of this group, 1 patient had a ureteral stricture, 3 had angulated ureters, and 15 had atonic bladders; in addition, there were 13 cases of pyelitis and 35 of cystitis.

Farrar (5), in speaking of the greater technical difficulties of total hysterectomy, makes the following statement: "I have never minimized the fact that a total abdominal hysterectomy is more of an operation to perform than a subtotal, but I do maintain that it is often the better operation for the patient. It seems to me major surgery would never have reached its present height if its

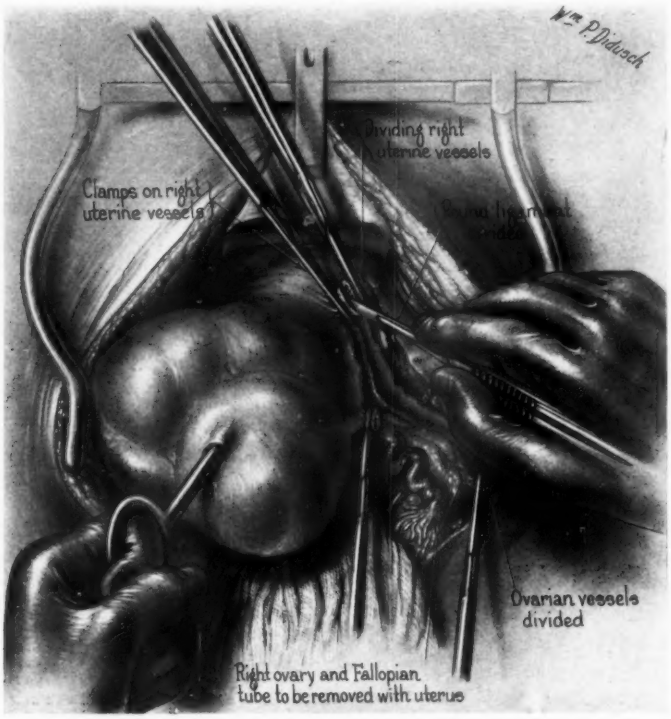
Clamps on right uterine vessels
Dividing right uterine vessels
Ovarian vessels divided
Right ovary and Fallopian tube to be removed with uterus

Fig. 2. One or both ovaries are preserved or removed depending on type of tumor, the patient's age, and other factors, this step of the technique varying with individual conditions. The uterine vessels are clamped and divided, the round ligaments are divided and ligated and, in case of removal of the ovaries, the ovarian vessels are secured.

standards had been kept on the level of the *least trained surgeon.*" A terse, significant, and accurate statement. However, this author points out that, in 510 consecutive total abdominal hysterectomies performed by 37 surgeons in a hospital devoted strictly to diseases of women, the total operation had the greater morbidity rate. It might be concluded that not all those who operated were "experts."

In the Farrar series there were 406 total hysterectomies for benign conditions, with a mortality of 1.9 per cent. In the same institution, in a series of 1300 operations performed prior to 1938, the mortality for supravaginal hysterectomy was 2.2 per cent. It was shown that more than half the deaths were due to infection, an obviously preventable condition, and, therefore, it was emphasized that one of the most important things to consider in mortality reduction is a more thorough preoperative preparation of the vagina.

THE OPERATION

The senior author believes that it would be appropriate to describe an operation of his own devising which, perhaps, is no more than an elaboration of procedures suggested by others. It employs certain instruments, in particular a vaginal clamp which simplifies the operation, rendering it no more difficult nor time consuming than the operation in which the cervix is permitted to remain. In the author's experience it has been marked by satisfactory low mortality and morbidity rates. The mortality for 170 consecutive patients operated upon by this method was 1.1 per cent. The average period of hospital stay for the last 100 consecutive patients, was 13.3 days, 56 per cent of the patients returning to their homes within 12 days or less. Two patients in the series died. In both instances autopsies were performed. It was found that 1 patient had an intestinal obstruction due to adhesions from a previous opera-

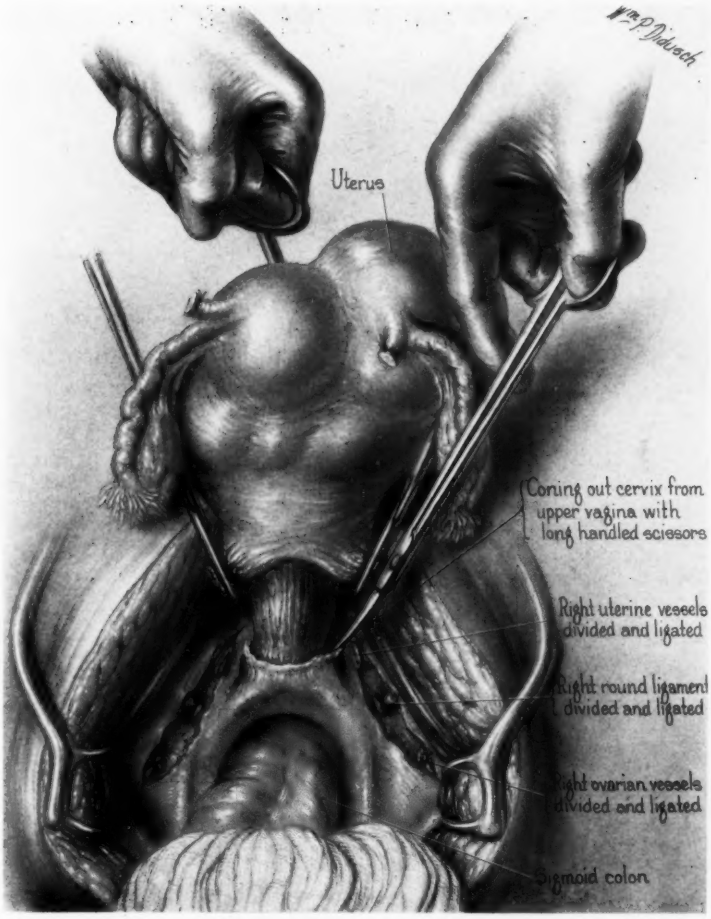
Uterus
Coring out cervix from upper vagina with long handled sciesors
Right uterine vessels divided and ligated
Right round ligament divided and ligated
Right ovarian vessels divided and ligated
Sigmoid colon

Fig. 3. After the isolation and division of both uterine arteries, the uterus and cervix are carefully dissected free from the surrounding cellular structures, great care being taken to remain close to the cervix so as to avoid damage of the ureters.

tion while the other died from pelvic sepsis, due possibly to incomplete vaginal preoperative preparation, obviously an avoidable condition. The 156 total hysterectomies performed by this technique were carried out for the relief of the following conditions: fibroids, 112; carcinoma of fundus or cervix, 14; endometriosis, 9; carcinoma of ovary, 3; in conjunction with removal of ovarian cysts, 9; in addition to abdominoperineal resection for carcinoma of rectum, 1; miscellaneous pathological processes, 8.

Technique.—The patient should have a cleansing douche administered the evening before the operation followed by the introduction of a vaginal antiseptic that is germicidal, but not irritating. The following morning, after the anesthetic has been administered, and our preference is for spinal almost routinely, the patient is placed in the lithotomy position, and the vagina again is thoroughly cleansed. The solution used is one which we apply in abdominal skin preparations. It was developed at the University of Minnesota by Novak. It is nonirritating, is powerfully germicidal, and has proved a most satisfactory medium. The formula for the cleansing solution is given as follows:

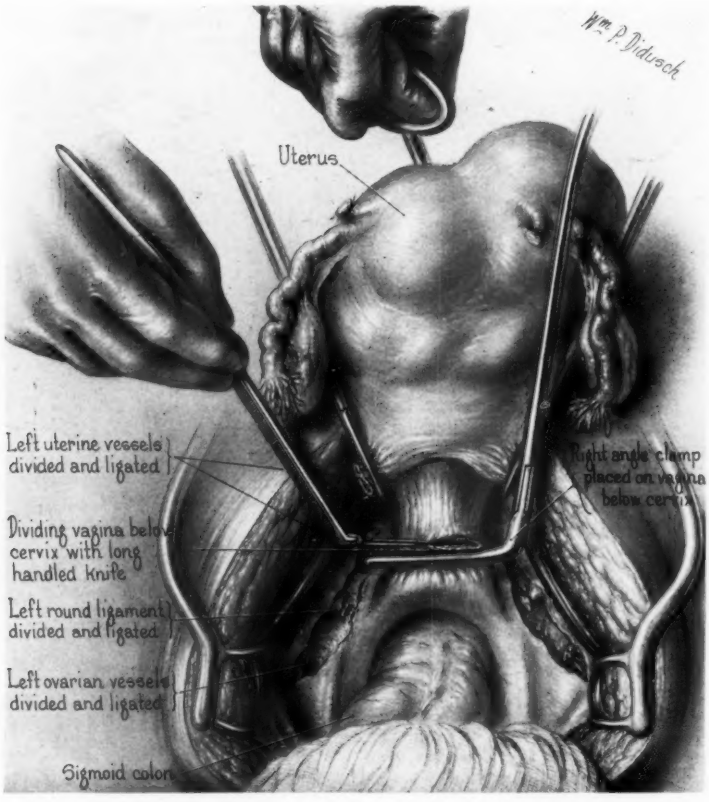
Wm. P. Didusch
Uterus
Left uterine vessels divided and ligated
Dividing vagina below cervix with long handled knife
Left round ligament divided and ligated
Left ovarian vessels divided and ligated
Sigmoid colon
Right angle clamp placed on vagina below cervix

Fig. 4. With bleeding from the uterine and cervical vessels controlled, the bladder is pushed well away from the dome of the vagina, it being replaced anteriorly by means of a bladder retractor. A special right angle clamp is then placed across the upper portion of the vagina, immediately below the cervix, and firmly locked. The upper vagina is then divided, just above the clamp, with one sweep of the right angle knife.

Cleansing Solution Formula

Alcohol (95%)....525.0 c.c.	Tricresol (Lysol)...5.0 c.c.
Acetone.....100.0 c.c.	Mercuric chloride..0.7 gm.
Water.....375.0 c.c.	Eosin Y.....0.6 gm.
	Acid fuchsin .....0.08 gm.

The patient is placed in the Trendelenburg position, and the usual vertical incision between the umbilicus and the pubis is made, which, in case of a large tumor, is carried to the left and above the umbilicus. After the peritoneum has been opened and the wound is protected with towels, a Balfour retractor is inserted and the intestines are gently packed off in the upper abdomen. Traction is then placed either upon the fundus or on the tumor itself. When the tumor is a myoma, a corkscrew type of retractor will be found particularly helpful. The ovaries are preserved, or removed, according to the indications, the patient's age, and the type of tumor. If the ovaries are to be excised, the broad ligaments are clamped and the ovarian vessels are secured and ligated. The peritoneal reflexion covering the bladder and the anterior surface of the uterus is carefully divided, and the bladder is pushed well downward and anteriorly. This step is extremely important. The bladder should be thoroughly separated from the anterior surface of the cervix and the upper vagina; otherwise, in the later stages of the operation, there is a possibility of its being injured by the needle or by the right angle clamp to be described later. By carefully dissecting the bladder from the anterior surface of the cervix and holding it well forward by means of a retractor, damage to it can be completely avoided.

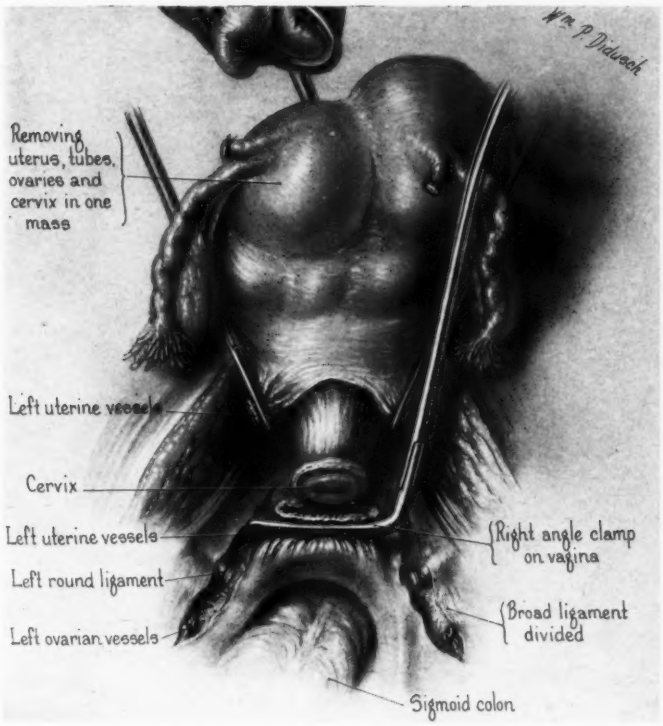

Fig. 5. The uterus, with tubes and ovaries, provided they are to be removed, is then removed from the pelvis. Contamination from the vagina and bleeding from its divided surfaces are completely controlled by the clamp.

The incision is now carried down until the uterine vessels are exposed, at which stage they are clamped, divided in the usual manner, and secured by a transfixion suture. Meanwhile, the round ligaments have been divided close to the uterus and ligated. The stumps of the uterine arteries are then gently pushed downward by means of gauze sponges after which branches of the cervical arteries are secured and tied. The positions of the ureters are definitely determined and constantly borne in mind. While firm, upward traction is maintained on the uterus, the cellular tissue overlying the cervix is divided, the dissection being kept close to the cervix at all times so as to avoid the ureters. Continuing the operation, the dome of the vagina is separated, anteriorly, from the cellular structures between it and the bladder as well as laterally and posteriorly, in the same manner. Areolar tissue attached to the cervix should be gently pushed down by means of a piece of gauze held in a pair of long finger dressing forceps. One must be sure that the ureters are well out of the way before application of the transverse vaginal clamp which is then applied across the upper portion of the vagina, immediately beneath the cervix, and locked firmly in position. By means of the angle knife the vagina is cut across immediately below the cervix and above the jaws of the clamp. The clamp completely prevents contamination from the vagina and effectively controls bleeding from the cut margins of the vaginal walls. The tumor is then removed in one mass together with the uterus and the cervix. The vaginal dome is next closed by means of a running mattress suture of chromic catgut placed back and forth beneath the clamp in an anteroposterior direction; then the clamp is removed, the suture being continued back across the vaginal cuff so as to pick up the severed margins of the mucous membrane in an over and over running suture. At this stage, it has been our custom, before implanting the round ligaments, to sprinkle

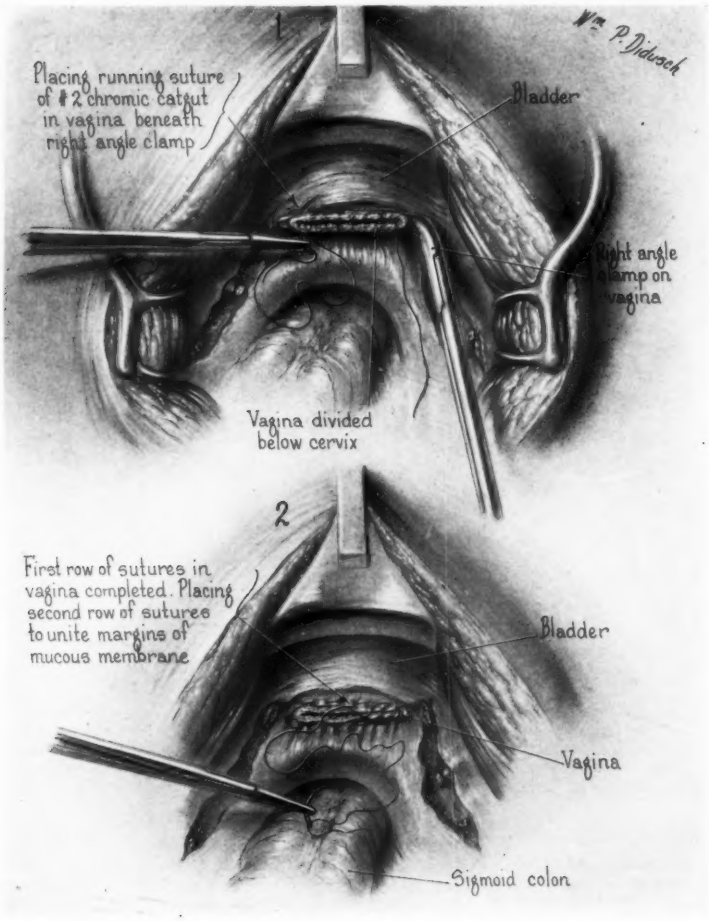
1
Wm. P. Didusch
Placing running suture of #2 chromic catgut in vagina beneath right angle clamp
Bladder
Right angle clamp on vagina
Vagina divided below cervix
2
First row of sutures in vagina completed. Placing second row of sutures to unite margins of mucous membrane
Bladder
Vagina
Sigmoid colon

Fig. 6. The vagina is then closed by means of a running, continuous, mattress suture of chromic catgut placed beneath the clamp. The clamp is then removed and the suture continued back as a continuous, overlapping one, placed in the vaginal margins. An excellent practice, at this step, is to sprinkle ½ gram of sulfanilamide over the exposed surfaces before peritonealization is carried out.

one-half gram of crystalline sulfanilamide over the stump of the vagina and surrounding raw surfaces.

The ligaments are then approximated. Frequently, if sufficiently long, they are overlapped and firmly sutured into the dome of the vagina by means of interrupted sutures of catgut so as to produce an effective support. The whole area is then thoroughly peritonealized by means of a continuous suture passing from one round ligament to the other and laterally from the dome of the vagina to the ligated ovarian arteries. Usually the lateral sutures are placed interruptedly for, if a continuous suture is used, there is danger of kinking and, possibly, of blocking the ureter (Fig. 7).

With most total operations, at the time of the removal of the cervix, the vaginal cavity is widely exposed. Such a condition presents no special danger if the vagina has been carefully prepared; yet it is unsurgical, even momentarily, to unite the cavity of the peritoneum with a highly infected mucous membrane, which might infect not

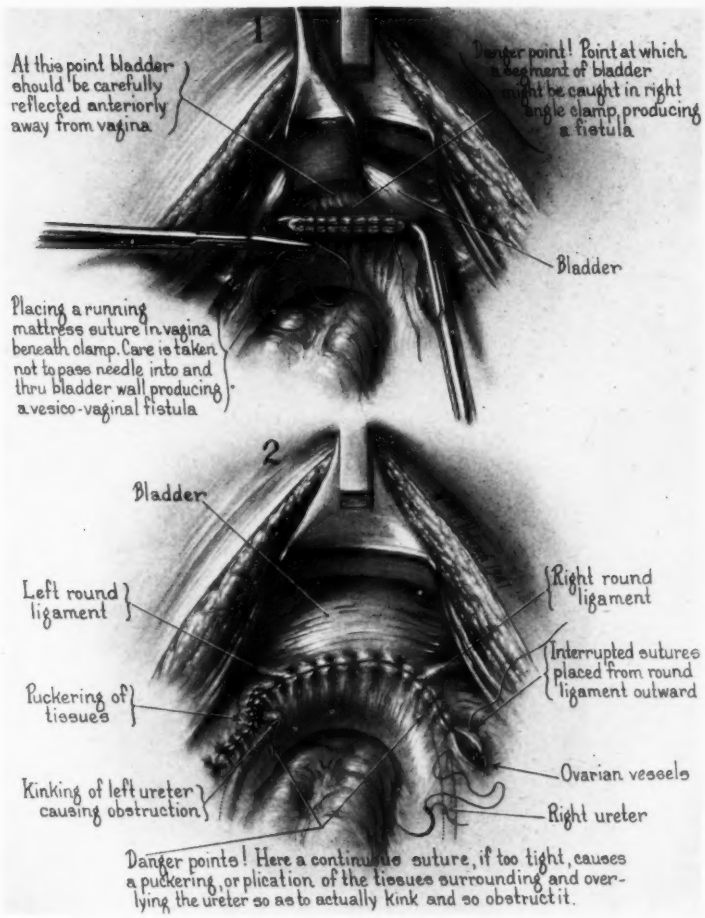
1
At this point bladder should be carefully reflected anteriorly away from vagina
Danger point! Point at which a segment of bladder might be caught in right angle clamp producing a fistula
Bladder
Placing a running mattress suture in vagina beneath clamp. Care is taken not to pass needle into and thru bladder wall producing a vesico-vaginal fistula
2
Bladder
Left round ligament
Right round ligament
Interrupted sutures placed from round ligament outward
Puckering of tissues
Ovarian vessels
Kinking of left ureter causing obstruction
Right ureter
Danger points! Here a continuous suture, if too tight, causes a puckering, or plication of the tissues surrounding and overlying the ureter so as to actually kink and so obstruct it.

Fig. 7. This illustration was especially prepared to emphasize two possible danger points in the operation. The upper figure illustrates the means by which the bladder is retracted forward. If this detail is not carefully observed, a suture may pass through the bladder wall or, a part of the bladder may be caught in the clamp producing a vesicovaginal fistula. In the lower figure, the importance of avoiding kinking the ureter is stressed and method of its prevention illustrated.

only the peritoneum but also the highly susceptible extraperitoneal tissue spaces which are necessarily exposed during the operation. In seeking an improvement in technique, it was evident that a desirable feature would be some device for firmly clamping the vagina and holding the margins of the severed mucous membrane in a closed position during suturing. The clamp effects this perfectly. The design of the jaws follows that of the smaller of the three Payr clamps used in stomach resections. Besides the usual pin found in the Payr clamp, a second pin, near the turn of the jaws, is provided, which effectively prevents the vaginal cuff from slipping laterally. The clamp is of rugged construction and is 9 inches long so that it will reach well outside the abdomen. The handles, flexed slightly to facilitate application of the instrument in the hands of the first assistant, are provided with a heavily constructed lock designed to secure the vaginal margins tightly.

A pair of long, curved, heavily constructed, Mayo dissecting scissors, facilitates dissection of

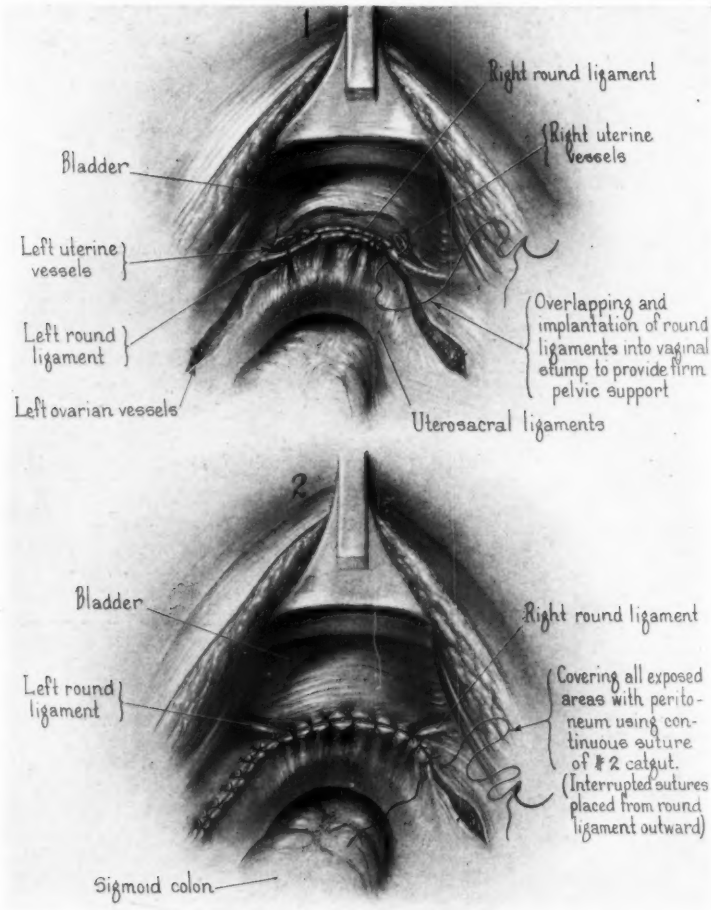

Fig. 8. Further steps in the operation are represented in this drawing which shows the means by which the round ligaments are sutured into the dome of the vagina to provide support. As a general thing, the round ligaments are approximated, or even overlapped, thus providing more support than is indicated in the illustration. The entire area is then completely peritonealized.

the cervix. A long handled, angulated knife holder, with the blade set at 110 degrees, constructed by Bard-Parker from the senior author's design, completes the set of required instruments. From time to time it is our custom to have the points of a dozen or so No. 10 Parker blades rounded off on a wheel. A stock of these blades is always kept on hand. Rounding the point prevents damage to the bladder at the time of sectioning the vagina.

In the performance of every total hysterectomy two possible dangers must be borne in mind. If they are forgotten, or if one becomes careless, all the advantages of total hysterectomy may be completely offset by complications which may not only add to the patient's period of hospitalization, but which may even result in a fatal termination. This operation, like other operations of a highly technical nature, must be skillfully performed. It should never be attempted with the easy confidence with which the surgeon might approach a supravaginal removal; yet it is an operation which should cause him no greater anxiety if he

Fig. 9.

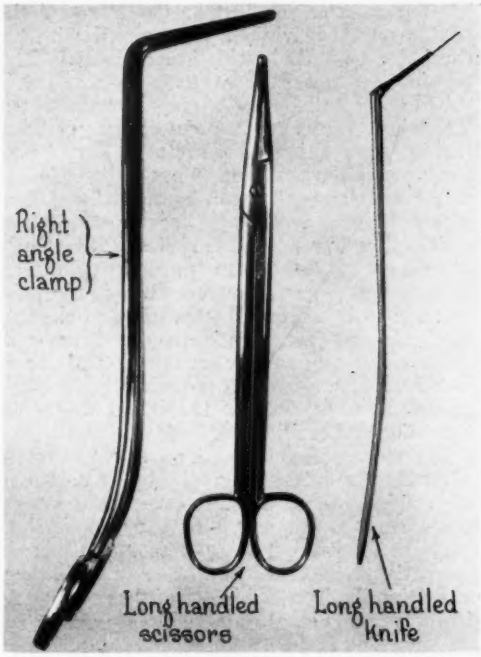

Fig. 10.

Fig. 9. The instruments which greatly facilitate the operation are here illustrated. They consist of: a, A right angle clamp of especially rugged construction, in the jaws of which are two pins which effectively prevent the vaginal dome from slipping laterally. b, A pair of long rugged Mayo dissecting scissors, the length of which is 9 inches. c, A right angle knife handle holding the usual No. 10 blade, the point of which has been rounded off on an emery wheel so as to avoid injury to the bladder.

Fig. 10. Lateral view of clamp and knife.

Fig. 11. The vaginal clamp.

Fig. 12. Close up of jaws of clamp.

Fig. 13. The right angle knife.

Fig. 11.

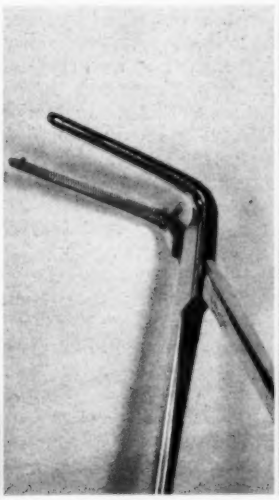

Fig. 12.

Fig. 13.

has the necessary skill, if he has mastered the anatomy of the pelvis, and if he proceeds with due caution, constantly bearing in mind certain dangers inherent in the procedure.

The first possible danger is injury to the ureter. There is no excuse for its occurrence if one bears in mind the position of the ureter or, better, if he has it under his eyes throughout the dissection. It may occur during the suturing of the broad ligaments and closure of the peritoneum laterally, at which time the ureter may be inadvertently kinked. If the sutures are pulled too tightly, especially if a deep continuous suture is used, the ureter may be angulated sufficiently to obstruct it. This complication cannot occur, however, if one keeps the ureter in view or constantly bears in mind its position, and particularly if one is careful to work close to the cervix during its dissection and excision.

The second danger is an inadvertent puncture of the bladder in the process of suturing the cuff of the vagina, which usually results in a vesicovaginal fistula. Either of these two complications may develop without being detected until late in the patient's convalescence. How to avoid them is graphically described in one of the accompanying drawings (Fig. 7).

SUMMARY

No one is unmindful of the fact that if total hysterectomy were performed routinely by all surgeons, by those of great skill as well as by those of limited experience in pelvic surgery, mortality would be high. The imperfectly trained surgeon or the surgeon with little experience who, let us say, performs not more than 6 or 8 hysterectomies a year, should confine himself to the supracervical procedure. It is probably true that if all hysterectomies were of the complete type, the final mortality would be greater than it is now with supravaginal hysterectomies, *plus* cancer deaths, resulting from neoplastic disease developing in the retained cervix.

"To advocate total hysterectomy to all surgeons throughout the country with all patients, to prevent the occurrence of carcinoma in the cervical stump, would cause far more deaths than would the carcinoma itself" (Meigs).

In a recent discussion before a medical gathering, it was mentioned that during the past 5 years in one hospital 280 hysterectomies had been performed by 10 operators. One surgeon stated that he was "convinced the mortality and morbidity of panhysterectomy is too high a price to pay for any possible advantages of the procedure." The average number of operations performed annually by each surgeon in this hospital was about 5. It is obvious that surgeons of limited experience should select the less formidable surgical procedure.

When does a surgeon become an "expert"? How many years must he work before he can be pronounced thoroughly skilled? How many operations of a given type must he perform before he may be considered particularly dextrous in the treatment of the condition for which this particular operation is performed? Given a technical procedure requiring great experience for its mastery, how many times must the surgeon carry it out before he becomes fully experienced? Fifty, one hundred, or five hundred times before he can be accepted as thoroughly proficient in the procedure? Consider two surgeons of equal ability. Which of the two is likely to be the more adroit, the one who performs the operation one hundred times each year or the one who does not complete his first hundred until the end of his tenth year. In aviation, skill is graded largely by experience, and experience is measured by the number of solo hours the pilot has flown. A flyer must have 35 hours of flying before he can obtain a private pilot's license. He must have two hundred hours before he can secure a commercial license. Moreover the airlines will not accept him even as a copilot until he has had at least one thousand hours in the air.

Of course, we cannot grade surgeons as we do aviators, yet it is logical to suppose that the surgeon who has performed a difficult procedure ten times does not possess the skill of the man who has performed it one hundred times. So it is with total hysterectomies. The surgeon who performs one or two hysterectomies a month should adhere to the supravaginal procedure. Such a man cannot consider himself broadly experienced. In all probability, the man who performs a hundred or more each year should be able to carry out the total operation expertly with a mortality no greater than that of the surgeon who adheres to the less formidable procedure.

We agree with Masson, with Richardson, and many others who have written on the subject, that it does not necessarily mean that "total abdominal hysterectomy is a dangerous and radical operation when performed by one experienced and proficient in pelvic surgery." It is not an operation for the occasional operator. It is an operation for a thoroughly trained and experienced surgeon. With him it is a safe procedure, and with the majority of patients requiring a hysterectomy total abdominal hysterectomy is, by all odds, the *best* procedure.

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ACUTE SUPPURATIVE TENOSYNOVITIS OF THE HAND

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SUPPURATIVE tenosynovitis of the flexor tendons of the hand presents a problem which has not been solved surgically. This problem is of extreme importance physiologically, surgically, and economically. Acute infections of the flexor tendon sheaths of the hand are relatively common and are frequently followed by total or partial loss of the part involved.

Results in the present group of cases show no improvement over those reported 30 years ago. Despite this fact much progress has been made in our knowledge of the anatomy, bacteriology, pathology, and therapeutics of tenosynovitis of the hand. This present study supplies some facts concerning the natural history, reveals defects in past treatment, and provides some suggestions which, if followed, should improve our results.

ANALYSIS OF STUDY

The material studied consisted of 100 cases of acute pyogenic infection of the flexor tendon sheaths of the hand, in which patients were treated at the Boston City Hospital. Most of the patients were followed for 20 months.

As to the origin of the infection, we found that it was either of (1) direct origin, in which case there was direct inoculation of the tendon sheath; or (2) indirect origin, in which case the infection spread from a neighboring pathological process. In this series 57 per cent were of direct origin and 43 per cent of indirect origin. In no case in the series did the infection spread via the blood stream—6 cases of gonococcus tenosynovitis, which are blood borne, are not included in this series. In no case did the infection spread via the lymphatic system. Forssell reported cases of lymphatic origin and Kanavel also believed that such infection could be of lymphatic origin.

The cases were classified on the basis of functional result:

In group 1—the bad results—are included (1) sloughed tendons with loss of flexion of the middle phalanx or distal phalanx, or both; (2) ankylosed proximal or distal interphalangeal joint, giving a stiff finger—motion in the metacarpophalangeal joint may or may not be present; (3) amputations; and (4) deaths.

In group 2—the fair results—are included (1) partial function of tendons, the limitation usually being caused by adhesions; (2) active, but limited, motion in the proximal or distal interphalangeal joints, or both. There may be normal or slightly limited motion in the metacarpophalangeal joint, fist cannot be made actively, but adjoining fingers may be used in making extreme flexion.

In group 3—the optimum results—are included (1) normal or almost normal function of tendons; (2) complete or almost complete flexion of the distal and proximal interphalangeal joints. There may be slight limitation of extreme flexion. Function of the fingers is practically as good as before infection.

As to the cause of the infection, we found that puncture wounds are the most common type of injury causing septic tenosynovitis. In infections of direct origin, puncture wounds occurred in 37 per cent, lacerations in 18 per cent, compound dislocation and gunshot wounds in 1 per cent. In infections of indirect origin, puncture wounds occurred in 5 per cent, lacerations in 12 per cent,

TABLE I.—BACTERIOLOGY AND CLINICAL COURSE

	Origin	Cases	Subcutaneous slough		Tendon slough		Osteomyelitis		Results Groups		
			Present	Absent	Present	Absent	Present	Absent	I	II	III
Streptococcus hemolyticus	Direct	31	17	14	13	18	10	21	12	9	10
	Indirect	8	5	3	4	4	3	5	5	1	2
Streptococcus hemolyticus, Staphylococcus aureus	Direct	11	9	2	8	3	6	5	8	2	1
	Indirect	18	13	5	11	7	8	10	11	4	3
Staphylococcus aureus	Direct	12	0	12	0	12	0	12	0	1	11
	Indirect	10	3	7	1	9	1	9	1	3	6
Streptococcus hemolyticus, Staphylococcus aureus, Vincent's spirilla	Indirect	6	6	0	6	0	4	2	6	0	0
Staphylococcus albus	Direct	1	1	0	1	0	1	0	1	0	0
Staphylococcus aureus, Bacillus proteus, diphtheroids	Direct	1	1	0	1	0	1	0	1	0	0
Streptococcus hemolyticus, Bacillus coli, Bacillus subtilis	Direct	1	1	0	1	0	1	0	1	0	0
Streptococcus hemolyticus, Staphylococcus aureus, diphtheroids	Indirect	1	1	0	1	0	1	0	1	0	0

abrasions in 8 per cent, human bite and felon in 6 per cent each, contusions and burns in 2 per cent each, and bleb and septic callus in 1 per cent each.

The primary site of infection in 50 per cent of the cases was found to be in the transverse volar creases of the fingers where anatomically the tendon sheath is devoid of its fibrous layer. The distal volar crease was the site in 27 per cent of the entire series, the middle volar crease in 16 per cent, and the proximal volar crease in 7 per cent. The closed spaces of the fingers were the primary sites in 37 per cent of the cases, the distal closed space was the site in 17 per cent of the entire series, the middle closed space in 12 per cent, and the proximal closed space in 8 per cent. The dorsum of the hand was the site of the infection in 12 per cent, and the entire finger was the site in 1 per cent.

A most important factor influencing the end-result is the time elapsed between the onset of infection and operation, or the delay in operation. However, time is not the only important factor; some hands operated upon within 24 hours did poorly, while others operated upon after 5 days did well. In group 1, the bad results, the average time before operation was 6 days, the least time before operation 24 hours, the greatest time 11 days. In group 2, fair results, the average time before operation was 5 days, the least time before operation 48 hours and the greatest time 9 days. In group 3, the optimum results, the average time before operation was 2.3 days, the least time before operation 20 hours, and the greatest time 5 days.

Table 1 is a summary of the bacteriology and clinical course in the 100 cases.

As to complications, 1 patient died of pulmonary embolus and a second patient from coronary thrombosis. In second patient the septic tenosynovitis was complicated by diabetes. These 2 deaths make a mortality rate of 2 per cent.

Osteomyelitis or stiff fingers caused by osteomyelitis or septic arthritis made it necessary to amputate in 18 per cent of the cases. Tendon slough was the most common cause of poor result and occurred in 41 per cent of cases. Osteomyelitis was relatively common and was found in 31 per cent of the cases. Involvement of the thenar space occurred in 18 per cent of the cases from tenosynovitis of the thumb, index, and middle fingers. In 2 of the 18 cases the origin was in the middle finger. The middle palmar space was involved in 12 per cent of the cases from tenosynovitis of the ring, little, and middle fingers. Incidentally, in 2 of the 12 cases with involvement of the middle palmar space the origin was in the middle finger. Septic tenosynovitis of the middle finger may be complicated by either thenar space abscess or middle palmar space abscess. In no case did a deep fascial space abscess spread to the forearm. Adhesions about tendons causing limited function were a complication in 10 per cent of the cases. Septic arthritis was found in 9 per cent of the cases. Lumbrical space abscess occurred in 9 per cent of the cases.

Involvement of the tendon sheath of the thumb occurred in 18 per cent of the cases. In 10 per cent of the entire series, the radial bursa became involved from tenosynovitis of the thumb, and in 8 per cent of the entire series both radial and ulnar bursae became involved from tenosynovitis of the thumb. Tenosynovitis of the little finger occurred in 6 per cent of the cases. In one half of this group, or 3 per cent of the entire series, the ulnar bursa became involved. In 2 per cent of the entire series both ulnar and radial bursae became involved from tenosynovitis of the little finger. In no case was there a spread of infection to the tendon sheath of the thumb from an original infection in the little finger.

In 3 per cent of cases there was a spread of infection to the space in front of pronator quadratus muscle in the wrist. In each of these cases tendon slough, radial and ulnar bursitis, and osteomyelitis occurred. In each case pus was found in the flexor carpi radialis tendon sheath and in the wrist joint. It cannot be definitely stated whether the spread to the wrist joint was by direct extension or via the sheath of the flexor carpi radialis tendon.

In 3 per cent of cases infection spread to the forearm spaces. In each case tendon slough, osteomyelitis, and infection of both radial and ulnar bursae occurred. In each case pus spread up the forearm into the space formed by the flexor digitorum sublimis muscle anteriorly and the flexor digitorum profundus and flexor pollicis longus muscles posteriorly.

Table II gives a comparison of end-results reported by several surgeons. A review of the literature reveals that, in the past 30 years, little progress has been made in securing better end-results in the treatment of acute septic tenosynovitis of the flexor tendons of the hand.

TABLE II—END-RESULTS

	Group 1 Bad Per cent	Group 2 Fair Per cent	Group 3 Optimum Per cent
Keppler (Berlin) 1912.....	28	10	62
Schiessl (Bardenberg) 1925...	28	14	57
Deicke (Leipzig) 1933.....	53	17	30
Grinnell (New York City) 1938	50	22	28
Present series.....	47	20	33

ANATOMICAL STUDIES AND SURGICAL TREATMENT

A mixture of 1 part of bismuth subnitrate, 1 part of cotton seed oil, and 2 parts of petrolatum may be injected, by the open method, into the tendon sheaths and the radial and ulnar bursae, and x-ray studies then made. By this method the comparative position of pus accumulations may be visualized. It is of value in determining the location and direction of incisions (Fig. 1).

Fig. 1. Tendon sheaths of the radial and ulnar bursae injected with radiopaque material showing comparative position of pus accumulations.

A knowledge of the surface anatomy and deeper structures of the hand is basic for the proper treatment of septic tenosynovitis. An understanding of the muscles, blood vessels, and nerves, particularly in their relationship to the tendon sheaths of the thumb and little fingers, is of great importance. A knowledge of the anatomy of the wrist and the spaces of the forearm, especially in relation to radial and ulnar bursae, is of much practical importance.

General anesthesia is always used. A blood pressure cuff is used for a tourniquet.

On the index, middle and ring fingers the middle and distal volar transverse creases extend to a point about half way between the anterior and posterior surfaces of the finger, on the medial and lateral aspects. The proper digital arteries are

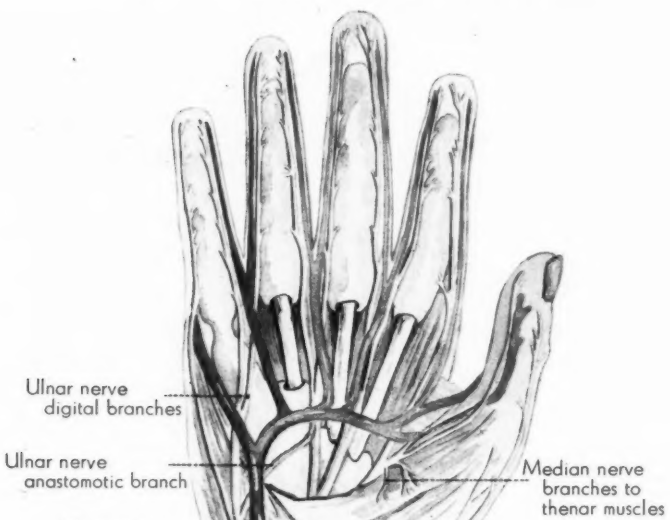

Fig. 2. Drawing showing median and ulnar nerves and ulnar artery.

slightly posterior to the digital nerves, and are found at the level of the anterior third of the medial and lateral aspect of the fingers.

Auchincloss has shown that digital arteries give off branches which form an anastomotic arch of blood vessels in the anterior subtendinous space. This anastomotic arch gives off vessels to supply bone, synovial membrane of joint and of tendon sheath, and the tendon itself. The tendon receives its branches through the mesotenons or so called ligamenta brevia.

In the surgical treatment of infections of the index, middle, and ring fingers several points may be emphasized.

Incisions should drain every pocket of pus. Interrupted incisions over the medial and lateral aspects of the proximal and middle phalanges have been used and discarded because drainage was incomplete; in too many instances secondary incisions were required and the incidence of tendon slough was too great.

Auchincloss has suggested the use of truncated flap incisions including all tissue down to the tendon sheath. In this incision, the distal end is cut along the flexion crease. The medial and lateral parts of the flap are cut obliquely downward, the digital vessels and nerves are avoided, and the incision is extended nearly to the next proximal crease. These incisions have been made over the proximal and middle closed spaces. Rubber tissue and thread have been used for postoperative drainage. The incision affords excellent exposure of the sheath but, in this clinic, the subsequent sloughing of tendons has been great. The exposure of the tendon may be too extensive. Also I have noted a rolling backward and often sloughing of some of the distal part of the flap, and this delays healing.

Medial or lateral longitudinal incisions which extend from the base of the distal phalanx to the level of the proximal volar digital crease and are placed anterior to digital vessels and nerves, have been used. These incisions are condemned as they necessitate cutting across the volar digital crease and this procedure endangers the vessels and nerves and may lead to herniation of tendons.

In this clinic the lateral incision has proved of greatest value. It extends from the distal crease

to the proximal volar crease. The incision is posterior to the lateral extensions of the volar transverse creases, and is posterior to the digital vessels and nerves. The only objection I find to it is that it involves cutting that branch from the digital artery which makes up part of the anastomotic arch of blood vessels in the anterior subtendinous space, from which the mesotenon is supplied. However, this small cut branch is not an end artery, and I believe that anastomotic circulation from the other side may be adequate to nourish the tendon sheath and tendon. This incision is followed by the least slough and provides adequate drainage. The sheath is nicked, a groove director is inserted, and the sheath is cut to the entire length of the skin incision. In almost all cases of septic tenosynovitis of the flexor tendons of the index, middle, or ring fingers, it is necessary to drain the palmar portion of the tendon sheath. This is accomplished by a longitudinal incision from the base of the proximal digital crease and carried about 2 centimeters proximally into the palm. The incision is begun on the same side of the digital crease as is the digital incision. The incision in the sheath joins that made over the digital portion. With index and ring finger infections the digital incision may be on the medial or lateral aspect of the finger. With tenosynovitis of the middle finger, the digital incision may be made on the medial or lateral aspects of the finger. If there is a complicating thenar space abscess, the incision should be on the lateral aspect. If there is a complicating middle palmar space abscess, the incision should be made over the medial aspect of the finger. In this series, 2 cases of tenosynovitis of the middle finger were complicated by thenar space abscess, and 2 cases were complicated by middle palmar space abscess (Fig. 4).

The sheath of the flexor tendon of the *little finger* extends from the base of the distal phalanx to about the metacarpophalangeal joint. On rare occasions, it may end there. However, it usually continues proximally in the form of the ulnar bursa.

The digital branches of the ulnar nerve to the adjacent sides of the ring and little fingers cross from the medial to the lateral side of the *ulnar bursa* at a point about 1 inch proximal to the metacarpophalangeal joint (Fig. 2). The anastomotic branch from the ulnar nerve to the median nerve crosses the fifth flexor tendon about 1.5 centimeters from the distal edge of the volar carpal ligament (Fig. 2). The ulnar artery, just before turning laterally to form the superficial volar arch, crosses the flexor tendon of the little finger, just anterior to the anastomotic branch of the ulnar nerve (Fig. 2).

Fig. 3. Pronator space and interflexor space showing muscular boundaries and attachments.

In the surgical treatment of infections of the little finger and palmar portion of the ulnar bursa the following steps are followed:

A longitudinal digital incision is made over the lateral aspect of the little finger, posterior to the digital vessels and nerves and posterior to lateral extension of the volar digital creases. If there is no continuity between tendon sheath and ulnar bursa, or if there is an obstruction to the spread of infection by the products of infection in the region of the metacarpophalangeal joint, there may be no need for carrying the incision into the ulnar bursa. However, it is necessary to drain the palmar prolongation of the tendon sheath. This is accomplished by making an incision about 2 centimeters long from the center of the volar aspect of the proximal digital crease into the palm (Fig. 4).

Clinical evidence usually reveals whether the palmar portion of the ulnar bursa should be incised. In this series one-half of the cases of tenosynovitis of the little finger were complicated by ulnar bursitis. However, if there is a question it is wiser first to cut into the septic tendon sheath, and then to exert pressure over the ulnar bursa, proximally. If pus is obtained with pressure, the incision is carried into the ulnar bursa. The palmar portion of the ulnar bursa is drained by an incision extending from a point just proximal to the distal transverse crease in the palm, to about the apex of the triangle in the base of the palm. This incision is over the lateral edge of the hypothenar eminence (Fig. 4). The digital branches of the ulnar nerve, about 1 inch proximal to the metacarpophalangeal joint, and the anastomotic branch of the ulnar nerve to the median nerve and ulnar artery, about 1.5 centimeters distal to the distal edge of the volar carpal ligament, must be identified and must be retracted medially (Fig. 2).

As to the anatomy of the thumb and palmar portion of radial bursa, the sheath of the flexor

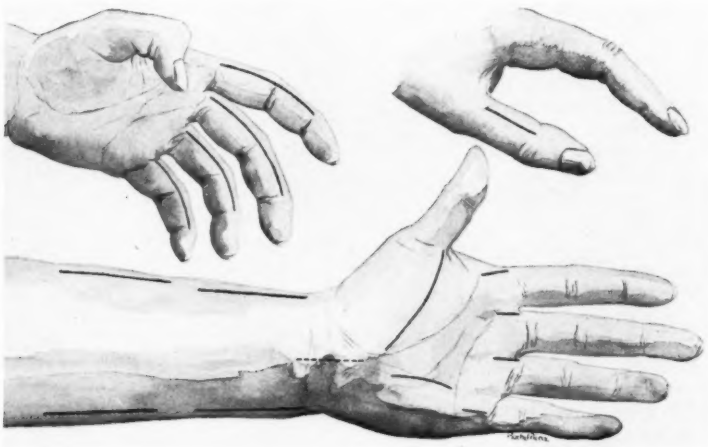

Fig. 4. Incisions for draining infected tendon sheaths, radial and ulnar bursae, spaces in wrist and forearm. Dotted line represents rarely used incision.

pollicis longus tendon extends from the base of the distal phalanx to about the middle of the first metacarpal bone, where it rarely ends. Usually it continues proximally beneath the volar carpal ligament, as the radial bursa, ending about 4 centimeters above it. At the level of the first metacarpophalangeal joint, the tendon sheath of the thumb lies between the head of the adductor pollicis medially, and the flexor pollicis brevis laterally (Fig. 2).

At about the level of the middle of the first metacarpal bone, a branch of the median nerve divides to send a branch to the medial and lateral aspects of the thumb (Fig. 2). The important motor nerves to the opponens pollicis, abductor pollicis brevis, and lateral portion of flexor pollicis brevis which rotate the thumb, arise from this branch of the median nerve, usually about 1.5 centimeters proximal to the digital branches (Fig. 2). At this level the tendons of the thumb lie between the two bodies of the flexor pollicis brevis. All these structures must be identified, otherwise the patient may be left with an insensitive thumb, and one which cannot be rotated. In this series, the thumb flexor tendon sheath was involved in 18 per cent of cases, and the radial bursa was involved in 10 per cent of the entire series.

In the surgical treatment of infections of the thumb it should be noted that the thumb should be placed in a position of abduction before an incision is made to obviate anatomical distortion, particularly of nerves. A longitudinal digital incision is made from the base of the distal phalanx to the base of the thumb, on the ulnar side. The palmar incision is a separate incision which starts at about the middle of the proximal volar crease, just below the center of the volar aspect of the thumb. The incision is then carried over the medial aspect of the thenar eminence about two-thirds the distance to the base of the thenar eminence. An incision is made into the sheath with care to avoid the sensory and motor branches of the median nerve. The portion of the radial bursa, proximal to where the nerves to the thenar muscles are found, is not drained unless the volar carpal ligament is cut. The distal three-fourths of the volar carpal ligament was cut in 2 cases in this series, not to expose the radial bursa but to relieve pressure and to avoid injury to median nerve and flexor tendons. Incisions through the entire volar carpal ligament should not be made because of the exposure to tendons and the prolapse of tendons (Fig. 4).

The *radial* and *ulnar bursae* are in close proximity beneath the volar carpal ligament. Anatomically, these bursae sometimes communicate. Clinically, it should be assumed they almost always do. In the present series 10 per cent of the entire group involved the radial bursa from tendon sheath infections of the thumb. From radial bursa infections, 80 per cent spread to involve the ulnar bursa.

Pus accumulations in radial and ulnar bursae may rupture into the space bounded posteriorly by the pronator quadratus muscle and anteriorly

by the flexor digitorum profundus and flexor pollicis longus tendons in the wrist (Fig. 3). In this series there was no tendency for thenar space and middle palmar space abscesses to rupture into this space.

From the wrist pus spreads up the forearm into the space bounded anteriorly by the flexor digitorum sublimis, and posteriorly by the flexor digitorum profundus and flexor pollicis longus. Dissection of the muscles of the forearm reveals why this is true (Fig. 3). The flexor digitorum profundus and flexor pollicis longus have their origin from the ulna, radius, and interosseus membrane from a point at the upper level of the pronator quadratus to the level of the oblique line of the radius. At the oblique line of the radius the flexor sublimis takes origin (Fig. 3). Thus, anatomically, pus cannot extend up the forearm behind the flexor digitorum profundus and flexor pollicis longus. It must spread anterior to these muscles. In the upper forearm the spread of pus is blocked by the origin of the flexor digitorum sublimis and pronator radii teres (Fig. 3). In its course pus spreads over the deeper muscles almost to the radial vessels on the lateral side, and beyond the ulnar vessels on the medial side.

If both ulnar and radial bursae are involved, and if pus has ruptured into the pronator quadratus space in the wrist, an incision on the ulnar side of the wrist may be adequate. A 2.5 inch incision is made at the anterior surface of the ulna, about 1 inch above the styloid of the ulna. The approach is behind the flexor carpi ulnaris and ulnar vessels. When the deep fascia is incised, the bulging ulnar bursa may be seen in the wound.

If the radial bursa alone is involved, an incision over the radial side of the wrist is made. A 2.5 inch incision is made over the volar lateral aspect of the radius, as close to the bone as possible, and posterior to the radial artery. When deep fascia is incised, the bulging radial bursa may be seen in the wound (Fig. 4).

Usually no drain is necessary for radial and ulnar bursae incisions, if the incision is sufficiently long. If great edema is present, a rubber tissue drain is inserted for 24 to 48 hours.

Most of the infections from the wrist tend to spread up the ulnar side of the forearm where most of the flexors are.

With infection of the intermuscular space of the forearm, a 2.5 inch incision is made between the flexor carpi ulnaris and the ulnar margin of the flexor digitorum sublimis. The ulnar margin of the flexor digitorum sublimis is retracted laterally, and the space between it and flexor digitorum profundus is entered by blunt dissection toward the profundus. Great care should be taken not to injure the ulnar nerves and vessels which are adherent to under surface of the sublimis (Fig. 4).

The incision over the ulnar surface of the forearm together with the wrist incisions is usually adequate. However, with extensive accumulations of pus, an incision is made over the radial side of the forearm. This incision is about 2.5 inches long along the outer edge of the flexor carpi radialis. At this point, the lateral edge of the flexor digitorum sublimis muscle can be identified, retracted inward, and the space entered by blunt dissection. The approach is internal to the radial artery.

Sulfonamides. Sulfonamides were used locally and parenterally. Certain factors should be understood in the intelligent use of the sulfonamides locally. The toxic action of sulfonamides on cells, when used locally, is not a big factor in influencing the selection of the drug. Lyons has suggested factors which should be kept in mind when selecting sulfonamides for local application, namely: rate of absorption, persistence of crystalline drug, persistence of drug by chemical test, excretion of drug, diffusion in wound, and tolerance for inhibiting substances. Sulfanilamide is absorbed more rapidly, excreted more rapidly, and persists as crystals and chemically in the wound for the shortest length of time and is more soluble in serum than other sulfonamides. Sulfathiazole, sulfadiazine, and sulfapyridine follow in decreasing solubility as mentioned. Sulfanilamide has the greatest rate of diffusion in wounds. Next in order, in rate of diffusion, are sulfathiazole, sulfadiazine, and sulfapyridine. Dead tissue slows the rate of diffusion through the tissues. Even in dead tissue, sulfanilamide diffuses more rapidly than do other sulfonamides.

Sulfonamides are bacteriostatic and not bacteriocidal. Theoretically, sulfonamides are supposed to act by interfering with bacterial enzymes concerned in some way with nutritive substances. Sulfonamides compete for bacterial enzymes with an essential metabolite, described as a substance or chemical group which takes an essential part in a chain of syntheses necessary for bacterial growth. Sulfonamide inhibition results from an excess of essential metabolite. MacLeod showed inhibitor substances in fresh muscle extracts and pus.

Sulfanilamide, sulfathiazole, and sulfadiazine have been used in this series. Locally these drugs have been applied as a light dust to in-

fected surfaces in a dose of about 1 gram per 10 square inches of surface as suggested by the subcommittee on surgical infections of the National Research Council. Sulfanilamide has been used with hemolytic streptococci alone, or in mixed infections. Sulfathiazole has been used with staphylococci in single or mixed infections. Sulfadiazine has been used more recently for hemolytic streptococcus, staphylococcus and all mixed infections. Recent clinical observations indicate that sulfadiazine may be the drug of choice. Sulfadiazine may have a superior tolerance for the local inhibitors.

Since the advent of sulfonamide treatment in purulent tenosynovitis there has been no great decrease in the incidence of tendon slough. This fact, I believe is due to the time factor. With septic tenosynovitis existing for 48 to 72 hours, it is quite obvious that the sulfonamides cannot be a great factor in correcting physiological changes which have occurred particularly in blood vessels, or in correcting pathological changes in the involved tissues, or in correcting the mechanical changes in the tendon sheaths.

Despite the fact that there has been no appreciable change in the incidence of sloughed tendons with sulfonamide therapy, there has been a decided decrease in the incidence of other severe complications in septic tenosynovitis. The decrease is noted in the incidence of osteomyelitis, thenar space abscess, middle palmar space abscess, ulnar bursitis, infections of the pronator quadratus space in the wrist, and the interflexor space in the forearm. If sulfonamide therapy is started early enough, it will undoubtedly be a factor in decreasing incidence of tendon slough. The marked decrease of severe complications of septic tenosynovitis with sulfonamide therapy is comparable to the decrease in mastoiditis with sulfonamides in otitis media.

POSTOPERATIVE TREATMENT

The infected hand should be elevated on a pillow at all times to facilitate venous and lymphatic drainage. During the stage of acute infection, the hand and wrist are immobilized in an aluminum splint, in a position of function. Early postoperative motion was instituted in a group in this series, but aggravation of the infection in almost every case was seen. It is strongly advised to permit no motion until the infection is controlled. However, with a sloughed tendon in the absence of osteomyelitis or septic arthritis, the joints may be manipulated to prevent adhesions, and permit future tendon grafting. Hot soaks are advised under aseptic conditions. If incisions are adequate, rubber tissue drains may be omitted in 48 hours. Many cases of septic tenosynovitis which have been doing well in the hospital have been discharged to the Out Patient Department, and tendon slough occurs. This, I believe is the result of permitting the patient to be ambulatory before the infection has subsided. Contamination of the wound, after discharge from hospital, has also occurred. Hospitalization of patient until the infection has subsided is of paramount importance.

SUMMARY

In 100 cases of acute septic tenosynovitis of the hand, the origin of infection was either by direct or indirect inoculation; in no case was it either of hematogenous or lymphatic origin.

On the basis of function, results may be classified in three groups, bad, fair, or optimum.

Etiologically, there were four outstanding factors; trauma, location of trauma, time, and bacteriology. Puncture wounds were the most common types of injury. Puncture wounds, particularly at the volar digital creases, caused the most serious infections. The thumb, index, and middle fingers were most frequently involved.

Time, or delay in operation, is the biggest factor in producing poor results. The average time before operation in group 1 was 6 days; in group 2, 5 days; and in group 3, 2.3 days.

In the group of cases in which the hemolytic streptococcus alone or combined with other bacilli caused the infection, the results were poor; in the group in which the Staphylococcus aureus caused the infection, the results were best; and in all the mixed infection cases the results were poor.

The mortality was 2 per cent. Amputations were performed in 18 per cent. Tendon slough, the most common cause of poor results, occurred in 41 per cent. Osteomyelitis was found in 31 per cent. Thenar space abscess occurred in 18 per cent and middle palmar space abscess in 12 per cent. Tendon adhesions caused limited function in 10 per cent. Septic arthritis was found in 9 per cent, and lumbrical space abscess in 9 per cent. Tenosynovitis of the thumb involved 18 per cent; spread to the radial bursa occurred in 10 per cent of the entire series, and from radial to the ulnar bursa in 8 per cent of the entire series. Tenosynovitis of the little finger occurred in 6 per cent with a spread of the infection to the ulnar bursa in one-half of the number of cases, or 3 per cent of the entire series, and to the radial bursa from the ulnar bursa in 2 per cent of the entire series. The pronator quadratus space in the wrist was involved in 3 patients and the inter-

flexor space in the forearm in 3 per cent of the entire series.

The average stay in the hospital was 19.9 days.

Results were generally poor: 47 per cent were in group 1, the bad results; 20 per cent in group 2, the fair results; and 33 per cent in group 3, the best results. Results in this series are no better than those reported 30 years ago and those reported by others.

CONCLUSIONS

The greatest hope for improvement in results lies in the early treatment of suppurative tenosynovitis and the proper observation of wounds of the fingers. Puncture wounds, at the digital creases in particular, should be considered as predisposing to suppurative tenosynovitis.

Extreme care not to change bacterial flora from a single strain to a mixed infection is of great importance. This danger is avoided by exercising strict aseptic precautions at the time of operation and particularly at the time of postoperative dressings.

Incisions should be adequate to drain every pocket of pus. Inadequate incisions invariably necessitate subsequent incisions and lead to poor results. Incisions may provide too much exposure to the tendons and thus produce a tendency to tendon slough or occasionally herniation of the tendon. Before an incision into a tendon sheath is made one must have a thorough knowledge of the surgical anatomy of blood vessels, nerves, and neighboring muscles. A clear knowledge of the pathway of pus in tenosynovitis is also basic. Rubber tissue drains may be used but are usually discarded in 24 to 48 hours.

The knowledge that an infection in any tendon sheath may complicate the treatment of an injury to the hand or fingers should make one alert to discover this complication early.

Sulfonamides, with sulfadiazine in particular, when used at an early stage, parenterally and locally, are of real value in decreasing the incidence of severe complications.

After operation, the hand should be elevated on a pillow to aid lymphatic and venous drainage. Active motions should be avoided until the infection subsides. The hand should be placed in an aluminum splint in a position of function. Dressings and soaks are performed with strict asepsis. With tendon slough but in the absence of osteomyelitis or septic arthritis, manipulation of the fingers is performed to prevent adhesions and to permit future tendon grafting. The patient should be hospitalized until the infection subsides.

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THE MODIFIED MIKULICZ RESECTION FOR CARCINOMA OF THE COLON

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THE historical development of the type of resection of the colon introduced by Bloch and developed by Paul and Mikulicz has been adequately reviewed elsewhere. Rankin's modification of the Mikulicz technique removed the serious objections to it. We believe that the reported recurrences of carcinoma in the abdominal wound following the original Mikulicz procedure were the result of extension of the growth from adjacent mesenteric glands which were not resected. One no longer sees these recurrences when the gland bearing mesentery is adequately removed.

Certain objections to the modified Mikulicz resection have been raised: first, that the gland bearing mesentery cannot be adequately resected; second, that this type of resection requires prolonged hospitalization; and third, that the mortality is high. In retrospect our experience with the Rankin modification seemed very satisfactory and led us to review a recent series in detail.

From January, 1938, to July, 1942, the senior author resected 77 lesions of the transverse and left colon by the modified Mikulicz technique. The distribution of these was as follows: sigmoid colon, 58; descending colon, 3; splenic flexure, 6; and transverse colon, 10. The pathological diagnosis in 71 cases was adenocarcinoma, and in one case each lymphosarcoma, endometrioma, obstructing diverticulitis, segmental ulcerative colitis with obstruction, megasigmoid, and a curious cystic degeneration of the collagenous fibers with ulceration of the mucosa in a two foot segment of a greatly elongated sigmoid.

Preliminary cecostomy for the relief of acute or subacute obstruction was done in 10 cases, or 13 per cent. Cecostomy was done once at the time of resection because of a coexisting diverticulosis of marked degree. The colostomy was closed as a secondary procedure in 66 cases. Spontaneous closure occurred in 11 cases, or 14.3 per cent of the series. Five, or 6.5 per cent, of the 77 patients died in the hospital, 3 of peritonitis and 2 of pneumonia.

TECHNIQUE

The technique of resection in this series was essentially that of the Rankin obstruction operation with a few modifications of the original description. The colostomy in each case was brought out through a vertical incision.

We wish to emphasize certain technical details which are important from the standpoint of both the cure of cancer and the reduction of mortality and morbidity. Mobility of the lesion to be resected determines whether this operation may be done. This mobility must be sufficient to satisfy two cardinal points: first, the wide resection of the adjacent mesentery, and, second, the proper formation of the double-barrelled colostomy. It is essential that the arms of the colostomy fall together to form a good spur without axial or vertical tension. The arms may be maintained in position by suturing together several appendices epiploicae, but the colon itself is never sutured, neither serosa to serosa, nor serosa to any part of the abdominal wall.

If the mesentery of the involved loop of colon is short, or if for any reason mobility is not sufficient, it is better to do a resection and anastomosis with complementary cecostomy or colostomy than to attempt a Mikulicz resection which might be inadequate for the cure of cancer and hazardous because of tension on the colostomy.

In the formation of the colostomy, care must be taken that the mesenteric borders of the bowel arms are placed in such a position that the spur clamp later will not crush the blood supply.

During the time that the Rankin clamp is in place we do not hesitate to pursestring suture a catheter into the proximal loop of the colostomy at the first sign of distention of the loop, or at the onset of generalized abdominal distention or cramps. The Rankin clamp is usually removed on the 5th postoperative day and the spur clamp is applied immediately. To be satisfactory, a spur clamp must crush without cutting and must ride lightly in the axis of the colostomy. It should be removed as soon as it feels loose to gentle tension. The position of the clamp should be inspected twice daily. After removal of the clamp, it is well to allow at least 48 hours to elapse before the colostomy is examined digitally since otherwise the sealed edges of the bowel may be disturbed intraperitoneally.

Closure of the colostomy should be a simple procedure, and the wound should heal promptly with only occasional transient fecal leakage, provided certain details in technique are observed. Sufficient time must elapse between resection and closure to allow the induration of the tissues about the colostomy to subside entirely. Ten weeks is the optimum interval.

The colostomy should be well mobilized and freed of its attachment to the fascia down to the peritoneum. It does not matter if the peritoneal cavity is actually entered, since local tissue immunity prevents any peritoneal reaction. The bowel must be trimmed of adherent fat and the rim of scar tissue about the stoma excised. The freshened edges of the bowel are sutured transversely with two rows of fine catgut. We prefer to close the fascia with interrupted alloy steel wire sutures and the skin and subcutaneous tissues with alloy steel wire vertical mattress sutures. Several small gauze wicks are placed beneath the fascia between the interrupted sutures.

With this technique patients are allowed out of bed on the 6th postoperative day and are discharged from the hospital on the 7th day. In this series of cases it has never been necessary to close a colostomy a second time.

Spontaneous closure of the colostomy saves the patient time and, in this respect, is desirable. Whether or not spontaneous closure occurs depends on how far below the skin edge the bowel retracts. Most of the colostomies in this series of cases were brought well out to the skin edges without tension, became adherent to the skin, and therefore necessitated closure. Occasionally, a mortality will occur from retraction of the loops under tension, and we believe that morbidity and mortality are decreased when the bowel loops are well mobilized and in full view at all times.

ANALYSIS OF STUDY

The Mikulicz type of resection may be applied to any portion of the colon sufficiently mobile to allow adequate resection of the adjacent gland bearing mesentery and the formation of an adequate colostomy. Since early in 1938 this operation has been preferred to resection with anastomosis in instances in which either of the two procedures might be indicated. The mortality for the Mikulicz procedure is low, and the morbidity is minimal. Furthermore, when the involved colon is mobile enough, the operation for the cure of cancer is as adequate as resection with anastomosis. The extent of resection in both types of operation is delineated by the blood supply in the same manner.

The Mikulicz procedure has been objected to on the grounds that it is a stage operation, and that it requires prolonged hospitalization not only for the resection but also for the closure of the colostomy. This need not be so, and in our experience the total duration of disability is only slightly longer than that following resection with anastomosis. In this series the average hospitalization for resection from the day of admission was 28 days. This figure includes preoperative preparation in all cases and 10 cases in which preliminary cecostomy was necessary for decompression. The average hospitalization for the closure of the colostomy was 8 days.

For a long time the senior author has advocated one stage operations in surgery of the colon. The closure of the colostomy according to the aforementioned technique has been uniformly successful and has carried with it so little morbidity and inconvenience to the patient that we no longer look upon it as a stage of an operation. Certainly the Mikulicz procedure cannot be placed in the same category as a two stage combined abdominoperineal resection or a two stage resection of the right colon.

We prefer this procedure for lesions of the distal two-thirds of the transverse colon, the splenic flexure, and the left colon. For lesions of the right colon and those just distal to the hepatic flexure, a one stage ileocolectomy with end-to-side ileotransverse colostomy has appealed to us as the best operation. The discharge of small intestinal contents after a Mikulicz operation on the right colon is discouraging to the patient, and the skin irritation is often difficult to control. In the poorer risk patients the loss of electrolytes and fluid from the ileum is not well tolerated. In addition the mortality of one stage ileocolectomy should not be greater than that of the Mikulicz operation.

There has been frequent discussion about the application of the Mikulicz resection to lesions at or near the "rectosigmoid junction." Apparently, there is no unanimity of opinion as to the location of this point. We consider the rectosigmoid junction to be a small segment of bowel beginning at the peritoneal reflection in the rectovesical pouch or cul-de-sac, extending proximally for not more than 2 inches. Most lesions at this point obviously cannot be exteriorized, and consequently ideas as to what constitutes the rectosigmoid junction must vary considerably.

Most lesions low in the sigmoid do not lend themselves well to this type of operation. Tension on the distal loop of bowel renders the procedure hazardous, and the amount of mesentery

resected is frequently inadequate. If the question arises as to the choice of procedure, we mobilize the bowel as in a combined abdominoperineal resection, preserving the blood supply, however. If sufficient mobilization cannot be secured, combined abdominoperineal resection is carried out. Although this necessitates a permanent colostomy, the mortality and morbidity are so much lower than when alternative procedures are used in this area that the combined operation is justified.

CONCLUSIONS

1. From January, 1938, to July, 1942, 77 modified Mikulicz resections were performed on the transverse and left colon. There were 5 hospital deaths, a mortality of 6.5 per cent.

2. The observation of certain technical points in the resection and closure of the colostomy reduces the mortality and morbidity.

3. In properly selected cases this type of resection is as adequate for the cure of cancer as resection with anastomosis.

4. There are certain objections to its use in the right colon and in the lower sigmoid.

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VOLVULUS OF THE SIGMOID

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VOLVULUS of the sigmoid occurs when the sigmoid is so redundant and the mesentery so relaxed as to permit a twisting of this part of the gut. The obstruction may be partial, complete, or strangulated.

Clinically significant redundancy of the gut may be congenital or acquired. Too much sigmoid may be a congenital abnormality; we will report a case of a 3 months old infant in whom the congenital factor must have been the only important one. We will report also a case of a patient who died at the age of 93 years from a strangulated volvulus of the sigmoid. In the latter patient it seems reasonable to assume that while the sigmoid was probably congenitally overlong, enough redundancy to produce strangulated volvulus would not have been present in the abdomen for 34,000 days without having produced symptoms. A study of the literature and of my cases convinces me (D.M.) that redundancy may be increased over a period of years to the point where it will cause strangulated volvulus. While the sigmoid may be long enough to permit volvulus in early infancy, those persons with less sigmoid may at first develop a partial volvulus only. Relaxation caused by age and repeated attacks of partial volvulus will gradually lengthen the mesentery and sigmoid until attacks of complete obstruction are followed by strangulation. Thus, volvulus of the sigmoid follows the well known law that many congenital abnormalities of the abdomen do not become manifest until adult life.

The symptoms at first are attacks of partial obstruction of the colon. Obstipation for a day is followed by a more or less distended abdomen and gas pains below the navel. Patients say, "If I could only pass the gas I would be all right." Sometimes they do pass some of the gas and some of the feces but not enough to get complete relief, so the attack continues. In one of our patients the attacks lasted from 12 hours to 2 weeks. Freedom between attacks varies from days to years. The tendency is for the attacks to become more frequent and more severe until the terrific pain of complete obstruction or strangulation sends the patient to a doctor.

From the surgical and roentgenological services of the King County Hospital and Providence Hospital.

Before obstruction occurs there may be tenderness on the left side and occasionally the redundant sigmoid may be palpated above the navel on the left side. It seems like a phantom cyst that disappears as it is being examined. X-ray examination at this time may not aid in diagnosis. Since one-third of all patients having barium enemas show some redundancy of the sigmoid, the roentgenologist may not usurp the clinician's rightful function of making diagnoses. The clinician likewise is apt to be thinking in terms of colitis, kidney disease, diaphragmatic hernia, or just nervous indigestion. Later, when hypertrophy of the redundant loop or obstruction has occurred, attention is directed to the sigmoid. When a patient has learned that an enema, especially one taken in the knee-chest position, will produce relief, recurrent volvulus of the sigmoid should be suspected.

The incidence of recurrent volvulus of the sigmoid is more common than the diagnosis. Bloodgood reported 1 case among 103 cases of intestinal obstruction. Hays reported 5 cases among 110 cases of intestinal obstruction and quotes Briggs in the *Ohio State Medical Journal*, 1912, as having stated that "volvulus of the sigmoid causes 15 per cent of intestinal obstructions." In the King County Hospital, Seattle, Washington, from 1934 to 1941 inclusive, 496 patients with intestinal obstruction were admitted. Of these cases the following 5 were due to volvulus of the sigmoid:

CASE 1 (110–959), a woman 93 years old, was admitted March 16, 1938, with cyanosis and an irregular pulse. She was in a very critical condition and died 24 hours later. A distended abdomen with generalized tenderness but no masses was noted. At autopsy a diagnosis of gangrenous volvulus of the sigmoid with peritonitis was made. Volvulus had not been suspected before autopsy.

CASE 2 (5149), a man 80 years old, was admitted November 11, 1937, with cerebral concussion and fractured ribs; he was irrational. Eighteen days later he was walking about the ward although he was confused mentally. He suddenly expired December 22, 1937. At autopsy by a coroner the findings were: fractured left 2d, 3d, 4th, and 5th ribs, abscess of chest wall, abscess of left kidney, cerebral atrophy, and redundant sigmoid and volvulus with partial obstruction.

CASE 3 (105053), a 28 year old Indian woman, was admitted October 4, 1937. An appendectomy had been done 1 year before and was followed in a month by several attacks of abdominal cramps and vomiting. The present attack was of 3 days' duration. The abdomen was distended

TABLE I.—SUMMARY OF CASES

From the Records of King County Hospital

Sex	Age	Duration of symptoms	Surgical procedure	Results
F	93	Diagnosis at autopsy only	None	Deceased day after admission
M	80	Diagnosis at autopsy only	None	Deceased
F	28	1 year or more	Simple reduction of volvulus	No follow-up
F	46	Before operation, unknown. After operation at least 4 years	Simple reduction of volvulus	Continuation of symptoms
F	3 mos.	Unknown	Simple reduction of volvulus	Recurrence of distention and death day after surgery
		Author's Private Cases at Providence Hospital		
F	37	At least 7 years	Resection with primary end-to-end anastomosis	Symptom-free for 2 years, followed by death from undetermined causes
F	31	Probably 11 years	Appendectomy and resection with primary end-to-end anastomosis	Symptom-free to date
F	23	"For years"	Appendectomy and resection with primary end-to-end anastomosis	Symptom-free to date
M	13	2 years or more	Resection with primary end-to-end anastomosis	Symptom-free to date
M	39	5 years	Appendectomy and resection with primary end-to-end anastomosis	Walked from hospital 9 days after operation. Bowels functioning normally

and there was visible peristalsis, there was no tenderness or rigidity. A ventral hernia was present but it was not incarcerated. She had vomited only during the past 24 hours. She was operated upon the day after admission with simple reduction of the volvulus. She was discharged October 23, 1937, and there was no follow-up.

CASE 4 (3997), a woman 46 years old, was admitted February 3, 1936. She had been admitted 3 months earlier and a diagnosis of obstruction relieved by enemas was made. The second attack followed the absence of a bowel movement the day before. She had cramp-like pains, a distended abdomen, and tenderness and rigidity of the lower left quadrant with nausea. At operation the volvulus was untwisted and reduced. Postoperative recovery was normal, and she was discharged from the hospital February 18, 1936. She was admitted to the hospital a total of 6 times before and after surgery and a diagnosis of intestinal obstruction or fecal impaction was made. She went to the out-patient department several times in 1940 with the same complaints.

CASE 5 (68969), a 3 months old baby girl, was admitted October 17, 1934, and a diagnosis of malnutrition with progessive abdominal distention was made. Acute intussusception was suspected on November 18, 1934. At operation the same day the symptoms were found to be caused by volvulus of the sigmoid. The volvulus was reduced, but the next day distention recurred and the baby died. There was no autopsy.

TREATMENT

Treatment of this condition in the past has not been a signal success. In 2 of the 5 cases at the King County Hospital the diagnoses were not made until after death. Simple untwisting of the volvulus either with or without passing of a rectal tube may give temporary satisfaction to the surgeon, but who can say when the condition will recur (3)? Plastic operations either on the mesentery or on the colon have invariably failed. Bloodgood's first case had 32 hospital admissions between 1890 and 1906 with 2 operations before the final cure. The surgeon is often astounded at the time of a second operation to find that there is no vestige of the carefully planned and painstakingly performed previous operation (4). The redundant sigmoid must be resected to effect a cure.

In the presence of acute obstruction, primary resection is usually considered hazardous. However, Hays resected sigmoids and did side-to-side anastomoses 4 times in the presence of obstruction. The ends of the colon were inverted and brought out through the peritoneum. All patients recovered, 2 with fistulas. This method is the technique used by Bloodgood. The modern surgeon is much more apt to do an obstruction type of resection in the presence of obstruction as advocated by Rankin. This type is undoubtedly safer and at the same time curative.

In the absence of obstruction I recommend end-to-end union. Even if obstruction is present it may be relieved by enemas in the knee-chest position and the bowel prepared for surgery. I believe that this procedure is as safe as operating in the presence of obstruction, provided that (1) the abdomen is not silent, proving there is no strangulation, and (2) the attempt to relieve the obstruction is not persisted in too long.

The principles of end-to-end suture of the colon were well described by Lockhart-Mummery (4) in 1917 and reiterated in 1938 (5), 21 years later. Further study of the blood supply of the colon

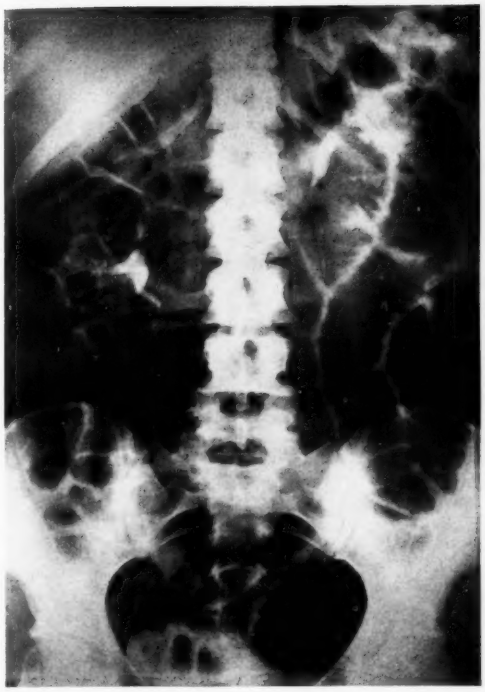

Fig. 1. Case 1. Flat plate taken during pyelogram. Note large redundant loop filling almost entire left side of abdomen. Significance was not realized at time of examination.

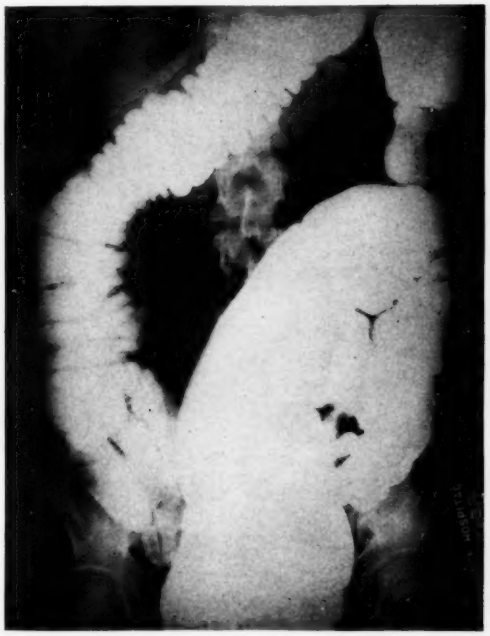

Fig. 2. Case 1. Roentgenogram taken after barium enema, showing large redundant loop of sigmoid. Note increased capacity of proximal colon.

(Steward and Rankin) and its clinical application (Metheny) makes the procedure even more certain. In my own 5 cases I used primary end-to-end anastomosis after resection of the sigmoid. During preparation the patient is given 1 gram of sulfanilamide every 4 hours for 36 hours just before surgery. An open technique is used, but it would seem the type of suture is not important provided the suture line is gas and water tight and does not impair the blood supply to the ends of the gut. The pad packing off the surgical field is moistened with metaphen. A continuous stitch of No. 00000 chromic catgut is first carried over and over, uniting the ends of the bowel. The serosal stitch is interrupted No. 60 cotton. A little sulfanilamide in Case 1 and sulfathiazole in Cases 2, 3, and 4 were placed around the suture lines as an added precaution. Postoperative distention is prevented by (1) continuous gastric suction through a Levine or Miller-Abbott tube, (2) prostigmin, and (3) insertion of rectal tube every 4 hours. When the Miller-Abbott tube is used, liquids by mouth are started the day after operation. Suction is discontinued on the 4th or 5th day. The reactions of my 4 patients were minimal and the last 3 left the hospital within 12 days after surgery.

Case 1. Miss N, 37 years of age, was first seen in September, 1939. She had enjoyed good health until 1927 when she had a severe attack of pyelitis. After that attack she had been addicted to morphine and her health had not been good. In 1932 she had an attack of severe abdominal pain, diarrhea, anorexia, and weight loss of 5 weeks' duration, but no diagnosis was made. In 1935 she had a great deal of epigastric pain. After a gastrointestinal x-ray study a diagnosis of colitis was made, and hemolytic streptococcus was cultured from her stool. Diaphragmatic hernia was also considered a possible diagnosis. Beginning in 1937, alternating diarrhea and constipation with fatigue prevented her from working 50 per cent of the time. Abdominal distention came and went during this time. During the previous 3 months there had been many attacks of abdominal pain and tenderness. Physical examination was normal except for a temperature of 99.4 degrees and an indefinite but tender abdominal tumor, mostly above and to the left of the naval. She returned to her home town for further examination.

Ten days later she came back and was placed in the Providence Hospital. Staphylococcus albus and nonhemolytic streptococcus were cultured from her urine, but an intravenous urogram was normal. X-ray at this time (Fig. 1) showed gas-distended intestines and close inspec-

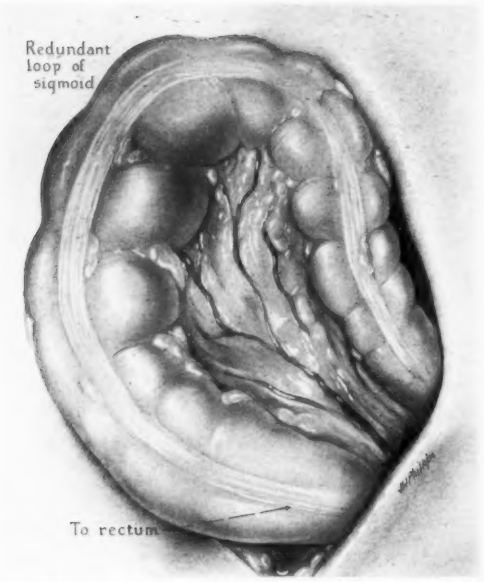

Fig. 3. Case 1. Artist's drawing of large redundant sigmoid at operation. Note increased diameter and hypertrophy of the bowel wall.

Fig. 4. Case 1. Roentgenogram taken after barium enema done 1 month after operation. There is still a slight amount of spasm. Note absence of redundant loop.

tion will reveal the large redundant loop of sigmoid. This was not noticed at the time, but a barium enema (Fig. 2) revealed the true cause of her abdominal complaints. Dr. Nichols actually saw the redundant loop twist and cause a partial volvulus under the fluoroscope. After several days' preparation the sigmoid (Fig. 3) was resected September 29, 1939, and end-to-end suture was easily done. Before resection the loop reached above the ensiform cartilage and the walls were hypertrophied. Convalescence was marked by difficulty in controlling drug addiction, and a small blister in the incision gave a pure culture of hemolytic staphylococcus. This blister looked as though it might develop into a phagedenic ulcer, but fortunately it healed promptly with the administration of neoprontosil intramuscularly.

This patient was seen many times after her operation and she always said that she had no more abdominal distress (Fig. 4) and that her bowels moved normally. She was still a morphine addict. On September 12, 1941, a telephone call from the White Cross stated that she had been admitted to the Northern State Hospital at Sedro Woolley, Washington. She had been going without morphine for 2 weeks and had gained 5 pounds. At 4:00 p.m., September 11, 1941, she was normal; at 4:30 p.m. she complained of gas pains; at 7:00 p.m. she was admitted to the infirmary and given morphine; at 9:15 p.m. she was in shock, and at 10:00 p.m. she was dead. No postmortem examination was made.

Case 2. Miss R, 31 years of age, was seen February 12, 1942. In 1931 she had a high white blood count and leucocytosis. The diagnosis was colitis and after that time she had been careful to avoid roughage and grease. She thought that fatigue made her colitis worse. In December, 1941, she had an attack of influenza and persistent fatigue and fever followed. Three weeks before coming to me she had severe abdominal pain that lasted for several minutes before breakfast. Four days before seeing me she had a terrific steady pain in the lower abdomen. She called her doctor who advised application of a hot water bottle, and the pain went away in 20 minutes. During the next 24 hours she felt bloated and she belched but had no bowel movement. The next day she had a normal movement.

Examination revealed nothing in particular except a tender, smooth, freely mobile mass between the navel and ensiform cartilage and there was blood in the stool. A flat plate x-ray of the abdomen (Fig. 5) was considered normal, but closer inspection will show gas in the redundant loop in the upper left quadrant. A roentgenogram (Fig. 6) taken after a barium enema on February 14, 1942, revealed the redundant sigmoid. On February 20, 1942, after several days' preoperative preparation, an appendectomy and resection of the redundant sigmoid with end-to-end suture of the colon were done. The redundant sigmoid easily reached above the ensiform cartilage. The operative specimen showed no abnormality except redundancy. The patient left the hospital March 4, 1942, 12 days after surgery. A roentgenogram (Fig. 7) taken after a barium enema March 19, 1942, showed absence of the redundancy.

Case 3. Miss W, 23 years of age, had intermittent abdominal cramps for years. These cramps came in definite attacks that lasted from 1 day to 2 weeks. They were without fever and sometimes associated with nausea and looseness of the bowels. She was entirely free of symptoms between attacks for periods as long as several months. Attacks had been more frequent and severe in the past year.

Fig. 5. Case 2. Flat plate of abdomen. Note in upper left quadrant redundant loop of large bowel filled with gas.

During physical examination on January 7, 1942, she was normal except for tenderness over McBurney's point. Report of the intestinal study was as follows: When an opaque meal was given there was no delay in the esophagus and the stomach filled smoothly and well. The position was much more to the midline and to the right of the midline than is usually seen, but there was no evidence of traction deformity. There was a large amount of gas in the transverse colon and descending colon, and this circumstance suggested that the displacement of the stomach was due to pressure from gas in the colon, although a part of such displacement may be congenital. There was no evidence of filling defect or abnormality and no delay in emptying. The cap filled smoothly and well. At the end of 5 hours there was no gastric residue, the head of the barium column was in the distal transverse colon which lay high under the diaphragm, and there was a large amount of gas present in this portion of the bowel and in the descending colon as well. The cecum was low in the pelvis and the terminal ileum appeared normal. The appendix was not seen. At the end of 24 hours there was barium throughout the colon with considerable residue in the cecum. Again the appendix could not be seen. An opaque enema (Fig. 8) was given and there was no evidence of obstruction or gross filling defect, but the sigmoid was unusually redundant and elongated, extending upward almost to the diaphragm; apparently this was the portion of bowel which was displacing the stomach. The sigmoid then passed downward to join the descending colon in the left iliac fossa. The splenic flexure was unusually high and the capacity of the colon was about twice that of the average bowel.

On February 25, 1942, after several days of preparation, an appendectomy and end-to-end suture of the colon were done after resection of the redundant loop. This loop easily reached above the ensiform cartilage before resection. The patient left the hospital March 8, 1942, 11 days after

Fig. 6. Case 2. Roentgenogram taken after barium enema, showing large redundant loop of sigmoid. Note increased diameter of proximal colon.

Fig. 7. Case 2. Roentgenogram taken after barium enema, 1 month after operation. Note absence of redundant loop.

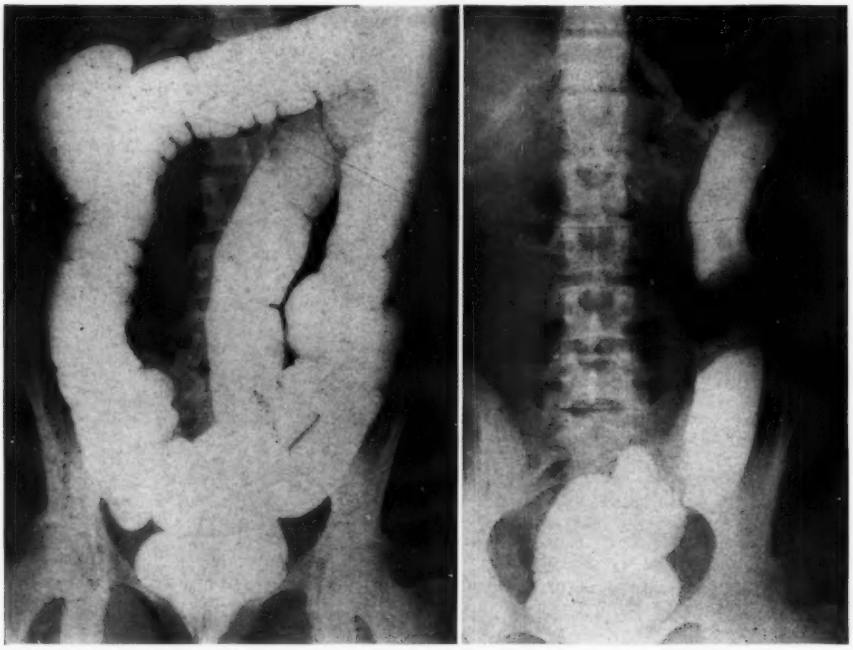

Fig. 8, left. Case 3. Roentgenogram taken after barium enema, showing large redundant loop of sigmoid. Note increased capacity of proximal colon.

Fig. 9. Case 3. Roentgenogram taken after barium enema, 1 month after operation. Slight amount of spasm can still be noted in the region of left sacroiliac joint where the anastomosis was done. Patient was symptom-free.

surgery. On March 27, 1942, another barium enema (Fig. 9) was given and the report was as follows: An opaque enema was given sufficiently to fill the distal colon, and there was no evidence of obstruction or gross filling defect. There was a slight tendency toward spasm at the junction of the sigmoid with the descending colon, but this filled completely under the fluoroscope, and there was no radiographic evidence of any permanent filling defect or abnormality. There was a marked reduction in the length of the sigmoid as compared with the previous films.

Case 4. Master W, 13 years old, was admitted to Providence Hospital March 21, 1942. Two years before he had had an attack of severe abdominal pain which had been diagnosed as left renal colic. The diagnosis had been made in the absence of hematuria or pyuria and in spite of the fact that no stone was found when the attack terminated. The pains had been so severe that renal colic was the only diagnosis considered. One year later an acute appendix had been removed but no other abnormality had been noted. For the past 3 months he had been unable to go to school. He had been having 1 or 2 attacks of severe pain daily in the left lower quadrant of the abdomen. The spasms of pain lasted for an average of 5 minutes. When asked to describe the attack he volunteered the statement that it felt as if something twisted. Asked if he could hear gurgling, he said, "No, but after the pain goes I can feel bubbles go by."

Physical examination revealed nothing remarkable. He was afebrile and undernourished. On palpation between the navel and left superior iliac spine there were tenderness and increased resistance that seemed resilient. The blood count, urinalysis, and pyelogram were normal, but a roentgenogram (Fig. 10) made after a barium enema revealed a redundant loop of sigmoid. The redundancy was not as great as in my other 3 cases, but most significant was the fact that the barium enema reproduced the pain of which he complained.

Operation was performed on March 28, 1942. There was a single adhesion between the cecum and the old abdominal scar; it was cut. There was a slight amount of clear serous fluid in the pelvis. A large redundant loop of sigmoid was found. Its apex was adherent by a congenital band of peritoneum to the left lateral wall of the abdomen. This acted as a swivel on which the redundant loop easily twisted and untwisted itself. About 12 inches of sigmoid were resected and end-to-end union was performed. Seven days later he was out of bed, and 10 days after operation he was well able to ride 80 miles home in an automobile. Four weeks after leaving the hospital he had gained 6 pounds, and he was not only going to school but was also helping his father with the farm work.

Case 5. Mr. S, 39 years of age, was first seen in consultation at the Providence Hospital May 18, 1942. In 1937 he had been admitted to the hospital for 10 days for abdominal pain and vomiting. His condition was diagnosed as appendicitis, but later the diagnosis was abandoned and he remained without any diagnosis until discharged. In 1938 he had several similar attacks and was readmitted to

the Providence Hospital for 10 days. He was in the hospital again for 10 days in 1939. A diagnosis was never made in spite of a roentgenogram (Fig. 11) made in 1940 after a barium enema was given. This film shows marked redundancy of the sigmoid. For the next 2 years he had recurrent attacks of pain associated with obstipation, bloating, and borborygmus. The obstipation often lasted 5 or 6 days. During this time the abdomen would become distended and he had to unbutton his trousers and loosen his belt 2 or 3 notches. He learned that taking an enema sometimes terminated an attack. At one time he weighed 4½ pounds less after taking an effective enema.

Physical examination revealed an adult who was healthy and normal in every respect. All laboratory examinations were normal except for findings after the barium enema (Fig. 12). The redundant loop of sigmoid was then twice the size it was 2 years before.

On May 22, 1942, 4 days later, resection of the redundant sigmoid and end-to-end union were performed, followed by appendectomy. Seven days later he was out of bed and his bowels had moved spontaneously. He left the hospital May 31, 1942. It is too soon to evaluate the final result, but he should have no further trouble as his bowels have continued to act regularly and without trouble since his operation.

CASE 6. No. 126735. The patient, a 65 year old man, was being treated at King County Hospital, Division No. 2, for an ununited fracture of the right hip. About December 1 he had an attack of acute abdominal distention and pain with obstipation that was relieved after 12 hours by enemas. Following the acute attack he complained of gas pains every day. About 7 p.m. every night, with massage of his abdomen, he expelled flatus and was relieved, but during the next day the abdomen would become slightly distended, he would again have cramps and again be relieved by the passage of flatus. He was admitted to Division 1 on my service (D.M.) the night of June 17, 1942. A diagnosis of acute low bowel obstruction was

Fig. 10. Case 4. Roentgenogram taken after barium enema, showing redundant loop of sigmoid. Loop is not as large as in other cases, but has symptoms because the entire redundant loop swivels on the adhesions at its apex.

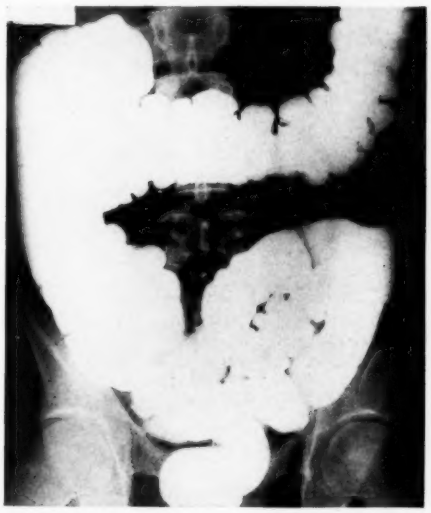

Fig. 11. Case 5. Roentgenogram taken in 1940 which was interpreted as normal in spite of obvious redundancy of sigmoid.

Fig. 12. Case 5. Roentgenogram taken 2 years later showing an increase in size of redundant sigmoid caused by recurrent volvulus.

made. The senior resident did a blind cecostomy under local anesthesia. The patient's recovery was uneventful. X-ray examination, however, showed that instead of a cecostomy a sigmoidostomy had been done in a large redundant sigmoid. July 16, 1942, Dr. Wm. B. Hutchinson resected, in one stage, the sigmoid with its fistula. The bowel was united end to end. Convalescense was uneventful. The patient was discharged September 18, 1942. There had been no further abdominal complaints and the ununited fracture was healed.

CASE 7. No. 160891. This 14 year old girl was admitted to my service (D.M.) at King County Hospital July 11, 1942. The temperature was 99.0 degrees and the leucocyte count 20,400, with 90 per cent polymorphlear leucocytes. In spite of the admitting diagnosis of appendicitis, Dr. P. M. Rogers, who saw the child, wrote on the chart that the leucocytosis was "out of proportion to the other symptoms." At the time of examination she was comfortable. There was some tenderness below McBurney's point, but no rigidity or bloating. Rectal examination showed tenderness on the right and there was blood on the examining finger. The mother stated that there had been many similar attacks in the past 6 months. The attacks were characterized by severe pain, vomiting and fever. X-ray examination of the colon on July 14, 1942, revealed a large redundant loop of the sigmoid. On July 20, 1942, the appendix and redundant sigmoid were removed, and a primary end-to-end suture was done. Convalescence was uneventful and the last note on her chart from the Out-Patient Department on September 21, 1942, said: "O.K., no complaints."

CASE 8. A. C. P., a 14 year boy was first seen in April, 1942, for loss of weight. He weighed 137 pounds and was 61 inches tall. He said he had lost 10 pounds in the past 6 months. No definite history could be obtained except that it hurt him to eat. On May 19, 1942, an x-ray diagnosis of redundant sigmoid with recurrent volvulus was made. A high caloric diet was advised in the hope that more fat in the sigmoid mesentery would prevent the attacks. In spite of all therapy he refused to eat and was sent to the Providence Hospital June 29, 1942, at which time he weighed 106 pounds. On July 3, 1942, the appendix and 18 inches of redundant sigmoid were removed. There was about 150 cubic centimeters of transudate and the redundant sigmoid reached almost to his knees. A primary end-to-end suture was done. On the 5th postoperative day he finished his lunch, escaped from the room and visited various diet kitchens throughout the hospital and ate an untold amount of food. He had some abdominal pains that night and told me the next day that the operation had not helped him any. However, he was discharged from the hospital on July 12, 1942. X-ray examination July 27, 1942, showed some spasm of the sigmoid but "it filled out completely, and the sigmoid appears normal in length." Following the x-ray examination he had two more attacks of abdominal pain that I think were due to spasm. Following this he acquired confidence in himself and started to eat normally. He was last seen November 2, 1942, when he weighed 137½ pounds and stated that he could not remember when he had had any abdominal distress, and that he felt well.

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EDITORIALS

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FEBRUARY, 1943

GEORGE CRILE

THE Editors of SURGERY, GYNECOLOGY AND OBSTETRICS announce with sorrow the death of Dr. George Crile. Dr. Crile served for many years on the Editorial Staff of the journal. An indefatigable research worker in scientific surgery and medicine, he will long be remembered for his many contributions to the art of healing. In a subsequent number of the journal more adequate recognition of his achievements will be presented.

THE LOCAL AND INTRAPERITONEAL USE OF SULFONAMIDE COMPOUNDS

AMPLE experimental and clinical evidence is available to establish the fact that the local use of sulfonamide preparations is an exceedingly valuable procedure in the prophylaxis and treatment of wounds sustained in civil life. Certainly, the evidence now at hand is substantial enough to justify the continued local use of these compounds under civil conditions. It would appear, moreover, that use of these preparations in treatment of wounds inflicted under conditions of war must be considered worth while until ample evidence to the contrary is available. The final assessment of the value of sulfonamides used locally must be obtained from accurate statistical analysis of a very large group of comparable wound infections.

Perhaps the greatest difficulty encountered in such a study would be the selection of a control. To find a dependable, untreated control series of war wounds under present conditions would be difficult. At present, sulfonamides are used almost routinely in treatment of wounds of any severity sustained in warfare; probably only insignificant wounds remain untreated with sulfonamides. Since some of the severe wounds become infected in spite of the use of sulfonamides and most of the insignificant wounds remain uninfected under ordinary antiseptic treatment, the conclusion might be drawn that the incidence of infection in war wounds is higher if sulfonamides are used than if ordinary antiseptic treatment is employed. Such a conclusion probably would be erroneous.

Therefore, it appears that the best evaluation of sulfonamide compounds, as used in treatment of war wounds, would be derived from comparing the rate of infection in wounds sustained under present conditions, wherein sulfonamides are used almost routinely, as has been said, with the rate of infection in wounds sustained in the war of 1914–1918, when sulfonamides were not available. The rate of infection in wounds studied by

bacterial culture at casualty clearing stations in the war of 1914–1918, was, according to available data, 75 per cent or more. For example, Stokes and Tytler,[1] of the British Army, obtained 310 cultures of aerobic bacteria out of 365 specimens taken, an infection rate of 85 per cent. In their series all attempts at culture were made within twelve hours after infliction of the initial wound. Certainly, it is difficult to conceive of infection rates this high with the present use of sulfonamides. In recent reports[2] of experiences in warfare, for example that of Long and Ravdin, the "incalculable value of sulfonamide therapy in the care of . . . casualties" is especially mentioned.

The question of the drug of choice and its method of administration in lacerations and wounds may not yet be settled. Of the many compounds available, the choice for local use probably should rest among sulfanilamide, sulfadiazine, and sulfathiazole. Little difficulty has been experienced following the local use of powdered or crystalline sulfanilamide. Some of the difficulties with sulfathiazole may easily be due to the rather large amounts of material used and to the fact that it has not been dispersed evenly over infected surfaces. If finely powdered or crystalline sulfathiazole is dispersed as a thin coating rather than being "packed" in these wounds, much of the irritation and foreign body type of reaction can be avoided. Sulfathiazole, from the point of view of its antibacterial activity, is polyvalent and is not a local irritant. If the mechanical problems involved in its application can be overcome, it is obviously superior to the monovalent compound sulfanilamide. Sulfadiazine may closely compare with sulfathiazole. The report of Green and Parkin[3] in a recent number of the *Lancet* seems to confirm the belief that sulfathiazole is the superior drug.

The "antisulfonamide" action of pus and tissue exudate may easily be overcome by frequent cleansing of infected surfaces, followed by reapplication of the powdered drug. This is essential in the early stages of infection. Other minor objections to the local use of sulfonamides, such as absorption into the general circulation, local damage to tissue and the development of resistant strains of bacteria are easily discountable on the basis of excellent experimental and clinical experience. Further, it is not necessary that the local agent penetrate deeply into the tissues. The actual culture medium for bacteria is the necrotic tissue and exudate. The deeper tissues possess an adequate capacity for combating infection. The additional use of sulfonamides administered other than locally requires more diligent observation of the patient. In combat zones this may be impracticable but it is, of course, a necessity in the presence of generalized infection. The frequent cleansing of wounds, with reapplication of thinly dispersed sulfathiazole does not, however, require skilled supervision and is entirely feasible.

There is one field in which these compounds have without question established themselves permanently in prophylaxis and treatment; namely, in intraperitoneal infection or suppuration. Practically all of the objections which have been raised against the intraperitoneal use of sulfanilamide or sulfathiazole can be refuted on the basis of clinical and experimental facts. Five to ten grams of the sterile, powdered drug should be introduced routinely into the peritoneal cavity in the presence of suppurative disease. Evidence is accumulating that prophylactically likewise this measure is sufficiently indicated. Such prophylaxis should be especially applicable under conditions of combat, wherein surgical

[1] Brit. J. Surg., 1918–1919, 6:92–124.
[2] J. Am. M. Ass., 1942, 118:465.
[3] Lancet, 1942, 2:620.

procedures on the abdomen are likely to be complicated by infection. In selection of a drug for intraperitoneal prophylaxis the following well defined criteria should be applied: (1) The drug should be active against a variety of micro-organisms; (2) it should, if possible, stimulate the local peritoneal defense mechanism and, at the same time, be innocuous to the peritoneum; (3) it should remain in fairly high concentration in the peritoneal space as long as possible, thus exerting prolonged bacteriostatic action.

Sulfapyridine and, to a lesser degree, sulfadiazine are definite peritoneal irritants and should not be employed for this type of therapy. Sulfanilamide meets some of the criteria postulated above. It is not a peritoneal irritant and does not depress the local peritoneal defense mechanisms. On the other hand, it remains in the peritoneal fluid for only twenty-four hours or even less. It is monovalent rather than polyvalent. Sulfathiazole is polyvalent. The material does not entirely leave the peritoneal fluid for a period as long as four or five days. Concentrations in the peritoneal fluid of 400 or 500 milligrams per 100 cubic centimeters are present following instillation of 5 to 10 grams. Cellular elements, particularly the mononuclear phagocytes, are markedly stimulated. There is no evidence of peritoneal irritation. Abdominal cavities opened subsequent to use of sulfathiazole have not revealed evidence of abnormal adhesions or other untoward effects.

It is not necessary to supplement the peritoneal administration of these drugs by oral or parenteral administration during the period when the peritoneal concentrations are high. The only exception to this would be the presence of some complicating disease or suppuration outside of the peritoneal cavity. Additional oral or parenteral therapy, under ordinary circumstances, will not alter the concentrations to any significant degree but may increase the hazard of toxic reactions. In the case of sulfathiazole, further treatment is not necessary for at least three or four days. Hepatic injury rarely, if ever, occurs if the proper interval is observed between the intraperitoneal implantation and the beginning of additional therapy. Hazards of renal injury are minimal and almost insignificant if urinary output is maintained at 1,500 cubic centimeters or more.

Investigators in general have experienced significant reductions in rates of morbidity and mortality following intraperitoneal use of these compounds in the presence of suppurative abdominal disease. Mortality rates for abscess and rupture of the appendix in one surgical center were more than halved in the first year of its use. Peritonitis is not commonly observed at necropsy since the introduction of intraperitoneal chemotherapy.

In view of what has just been related, it is believed that nothing should be allowed to interfere with use of one of the sulfonamides, preferably sulfathiazole, intraperitoneally in the management of infections which may occur under military conditions. Sterile packages of these compounds, weighing 5 grams each, should be part of every set of surgical supplies. Unsterilized powder can be used safely following subjection of the material to dry heat at 140 degrees C. for one hour. Moist heat is undesirable in preparing the material.

Local or intraperitoneal chemotherapy obviously does not displace accepted rational supportive and surgical procedures. All of the procedures are complementary. Disagreements and clinical contradictions are products of misunderstanding of the principles concerned in the successful application of all available methods of attacking wound infections.

WALLACE E. HERRELL.

RELATIONSHIP BETWEEN THE THYMUS AND MYASTHENIA GRAVIS

EVIDENCE of an association between myasthenia gravis and abnormalities of the thymus has been accumulating since 1901 when Weigert reported finding a tumor of the thymus in postmortem examination of a patient who had died with myasthenia gravis. By 1917 Bell was able to collect reports of 56 cases of myasthenia gravis in which the thymus had been examined at necropsy and noted that tumors of the thymus were found in 10 cases and thymic enlargement or persistence was found in 17 additional cases. In 1935 Norris added a number of cases to this series and in his remarks stated that "pathologic changes of the thymus may be found in cases of myasthenia gravis in direct ratio to the care with which they are sought." Blalock and his associates in 1939 and again in 1941 brought the evidence up to date by collecting data on cases from the literature and from their own experience to compile a total of 129 instances of myasthenia gravis in which the thymus was examined at necropsy or operation. They found that thymic lesions in the form of persistence, enlargement, or tumor of the thymus were observed in 71 instances, or 55 per cent of cases. In a recent publication Poer has noted that "during the last five years over two-thirds of the reported cases of myasthenia gravis in which the thymus was examined at autopsy or operation were found to have definite pathologic changes in the thymus."

At the Mayo Clinic, in the past year, 7 patients having myasthenia gravis were found to have roentgenographic evidence of intrathoracic tumors. In 3 instances, surgical removal and histological study verified the clinical opinion that the tumors were of thymic origin. Throughout the preceding years when thymic tumors were searched for less diligently only rarely were intrathoracic tumors detected in myasthenic patients. Thus, it seems that Norris' statement that the detection of thymic abnormalities varies with the care with which they are sought is applicable to clinical medicine as well as to pathology.

It must be admitted that the exact nature of the relationship here is not known at the present time. However, the association occurs too frequently to be considered coincidental. There is some evidence to suggest that myasthenia gravis may be an endocrine type of disease due to an abnormal secretion from the thymus having a curare-like effect. The thymus has often been considered to belong to the endocrine system; however, no definite function of the organ has ever been proved. According to most observers, extirpation of the thymus in the experimental animal does not produce any detectable alterations, and no secretion from the gland has ever been isolated. However, Adler recently has made studies which, if they can be confirmed, will form a very valuable contribution to our knowledge of the thymus and myasthenia gravis and definitely establish the thymus as a member of the endocrine system. He reported that the transplantation of thymus of puppies and calves to mature dogs and injection of extract of calves' thymus into dogs produced symptoms similar to those of myasthenia gravis and resulted in the myasthenic reaction to faradic current characteristic of the disease. He also reported that prostigmine relieved the weakness of the dogs just as it does that of patients having myasthenia gravis. This work has not been confirmed.

Further evidence that the thymus may be a part of the endocrine system is contributed by the fact that in thyrotoxicosis and in Addison's disease the thymus is enlarged and that

it undergoes an involution following thyroidectomy in cases of thyrotoxicosis or injection of cortical extract in Addison's disease. Likewise the gonads and the pituitary gland have been shown by some to have some definite influence on the thymus.

Although the rôle of roentgen irradiation of the thymus in the treatment of myasthenia gravis is not established, a number of observers have noted that roentgen therapy over the thymic region in cases of myasthenia gravis has produced improvement or remission of symptoms, and in some cases definite roentgenologic evidence of thymic enlargement disappeared following roentgen therapy. Our own experience has confirmed the beneficial effects of roentgen therapy for the relief of symptoms of myasthenia gravis in selected cases.

It is impossible at the present time to throw much light on the question of the association of myasthenia gravis and thymic abnormalities by pathological study of the hyperplastic thymic tissue or the tumors that have been found. There is considerable disagreement among pathologists regarding the pathological characteristics of all thymic lesions and the question of pathological changes in the thymus associated with myasthenia gravis at present seems only to add to this confusion. However, Norris' study of pathological characteristics of lesions of the thymus associated with myasthenia gravis is outstanding, and it is to be hoped that an increase of the amount of material available for pathological examination will promote studies of thymic pathology which may throw further light on this question.

It has been very difficult to evaluate the numerous methods of treatment that have been suggested because the disease is subject to spontaneous remissions and exacerbations. However, we have been fortunate in having prostigmine, which has been remarkably effective in controlling the symptoms of the disease. Ephedrine, guanidine hydrochloride, and potassium salts also have been beneficial, particularly when used in association with prostigmine. However, these have not been in any way curative. The evidence which has accumulated indicating the relationship of myasthenia gravis and thymic abnormality, together with the fact that roentgen therapy over the thymus produced relief of symptoms and the evidence that the thymus was closely associated with members of the endocrine system, naturally suggested the possibility of a surgical attack on the thymus.

Apparently the first attempt to influence the course of myasthenia gravis by surgical attack on the thymus was made by Sauerbruch and was reported by Schumacher and Roth in 1913. This patient was improved but continued to have evidence of myasthenia gravis. Sauerbruch subsequently removed thymic tumors from 2 other patients who had myasthenia gravis but neither patient survived. At the present time we have been able to collect only 11 instances of surgical attack on the thymic tumors in cases of myasthenia gravis, including 3 cases of our own. There were 3 deaths in the series, in 2 cases the myasthenia was not affected, in 3 there was improvement but symptoms persisted and 3 patients were apparently relieved of their symptoms. We had no deaths in the 3 cases in which we operated. In addition to these 11 cases, Blalock has reported 6 cases in which he performed thymectomy in cases of myasthenia gravis without evidence of tumor in the hope of influencing the course of the disease in this way. In 3 there had been progressive improvement at the time of reporting, in 2 improvement was not remarkable and 1 patient died.

It must be admitted that the surgical results in removal of thymic tissue or thymic tumors

in cases of myasthenia gravis have not been remarkable. This should not, however, lead one to disregard the evidence indicating an association between the thymus and myasthenia gravis. The subject warrants further study, particularly in the fields of experimental endocrinology, pathology, and muscle physiology. We believe that, in all cases of myasthenia gravis, the patient should be carefully examined for evidence of thymic abnormality and in this regard lateral roentgenograms of the chest and in some cases roentgenoscopy are extremely valuable. Naturally in dealing with a disease characterized by remissions, as myasthenia gravis is, we are reluctant to state that patients have been definitely cured by removal of thymic tumors. However, we feel justified in advising operation in selected cases of myasthenia gravis with tumors because patients have apparently been cured by removal of thymic tumors, because there are no good tumors, and because continued studies in this group of cases will contribute significantly to our knowledge of the relationship between the thymus and myasthenia gravis.

O. THERON CLAGETT.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE second edition[1] of this very excellent review of the treatment of war wounds and the wounded represents, as Hamilton Bailey says in the preface to the first edition, British surgery. The list of distinguished authors attests to the character of the work and the solid foundation upon which it is based. That such a task could be accomplished in the midst of a great war effort is an achievement which deserves very high praise.

There is considerable rearrangement of material as compared with the earlier edition; many colored illustrations have been added; and a number of new chapters have been included. Material included in the appendix of Volume II of the first edition is brought into its proper place, sometimes by the addition of new chapters. The discussion of blast, for example, becomes a part of Chapter 4, Volume I, on compression phenomena. A brief page on frostbite and trench foot becomes Chapter 51 of 17 pages in Volume II. A new appendix is added to Volume II which represents an effort to include the most recent contributions to surgical literature.

Sections on blood substitutes and transfusion, wounds of blood vessels and burns—among others—have been considerably enlarged. Although it is stated in the section on burns that sepsis must be eliminated from the onset one would wish that the simple expedient of mask for patient and first aid workers had been mentioned as essential in achieving that objective.

The task of preparing a new edition of these volumes on war surgery has undoubtedly been achieved under great difficulties and great pressure. We have only admiration for their general excellence and the serious effort they represent. They will be of unquestioned value to the surgeon faced with the problem of treating the wounded. SUMNER L. KOCH

IN the third edition of the 600 odd page book *Disability Evaluation*[2] by McBride the author, a pioneer in the field of industrial surgery, has enlarged and modernized most of the sections of the book. Added is a composite schedule of approximate evaluations for partial permanent disability which is very useful for reference in determining percentage loss in a given case.

The major portion of the book is devoted to ankylosis and fracture. Since these lesions occupy a large share of industrial work, such stress is probably well placed. Chapters on hernia and head injuries are brief, and the discussion of treatment in these sections should not be taken as a guide in their handling. An omission of importance is the failure to mention that careful cleansing and primary closure of compound wounds are desirable in favorable cases, particularly since these are more often seen in well controlled industrial cases than in any other group.

Used by many industrial commissions as a guide, this book is a necessity for the surgeon who must estimate disability in industrial cases.

THOMAS C. DOUGLASS.

INJURIES to the urinary organs occur in 15 per cent of all penetrating wounds of the abdomen and frequently accompany wounds of the buttock, perineum, and thigh. Yet this important subject has received but scant mention in the manuals of military surgery.

These injuries are often accompanied by associated intra-abdominal and pelvic lesions which frequently claim the spotlight. The urinary tract involvement is often overlooked or diagnosed late. Frequently it is not discovered until the abdomen is opened for the care of an intra-abdominal injury.

The early care of these patients is usually entrusted to men in the field and in evacuation hospitals who are not themselves specialists in urology and who do not have either the time or the inclination to struggle through the somewhat controversial and confusing literature on the subject. Hence these injuries have been handled poorly in the past and the mortality has been high. Nevertheless a review of the literature reveals not a few cases of patients who survived following early and adequate definitive care, even though the injury was surprisingly severe and extensive and complicated by considerable damage to other organs. Hence early and adequate care of such injuries offers a great hope of better results. The only chance of accomplishing this lies in making the front line and evacuation hospital surgeon "urinary injury conscious" and in giving him a few simple rules of thumb to start these patients along the proper path of treatment.

The standard textbooks on urology offer very little information on this important subject since the urologist in civilian practice has very little if any experience in handling such injuries. Hence there is a great need for a concise manual to guide the military surgeon in the recognition and treatment of urinary tract injuries which occur in warfare. *Urology in War*[3] by Charles Y. Bidgood seems to fill this

[1] Surgery of Modern Warfare. Edited by Hamilton Bailey, F.R.C.S. Vols. 1 and 2. 2d ed. Baltimore: The Williams & Wilkins Co., 1942.

[2] DISABILITY EVALUATION; PRINCIPLES OF TREATMENT OF COMPENSABLE INJURIES. By Earl D. McBride, B.S., M.D., F.A.C.S. 3d ed. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1942.

[3] UROLOGY IN WAR; WOUNDS AND OTHER EMERGENCIES OF THE GENITOURINARY ORGANS SURGICAL AND MEDICAL. By Charles Y. Bidgood, Lt. Comdr. (M.C.) U.S.N.R. Baltimore: The Williams & Wilkins Co., 1942.

need. This small, exceedingly well written volume of only 76 pages shows the results of considerable study and condensation; and for so short a volume it is surprisingly complete. Its scope is limited mainly to acute traumatic and inflammatory lesions of the urinary tract which are apt to occur in warfare; and it is intended mainly for the guidance of the surgeon in the field and on shipboard who is not himself a urologist. By confining himself only to the most essential information and through a dogmatic presentation, which in each case usually limits itself to a single mode of procedure, the author has succeeded in avoiding confusion and in clarifying a rather difficult subject. The reviewer wishes, however, to take issue with a few of the recommendations in the book. Among these, the administration of a blood transfusion into the corpus cavernosum penis and the recommendation to dilate urethral strictures to No. 30 to 35 F. with a Kollmann dilator seem rather drastic; and since they are not standard procedures might better not have been included in this volume.

FREDERICK LIEBERTHAL.

EXHAUSTIVE studies of the blood cells in cancer over a period of 27 years have convinced Gruner[1] that they give more accurate results in the diagnosis of cancer than any other tests. His routine examination of the blood consists in: (1) a study of living blood by using lowered condenser, crossed Nicol prisms, and dark ground illumination, and (2) a study of stained blood films in respect to red blood cells, leucocytes, and platelets. In a résumé, he states that cancer is most certainly not present if there is well marked rouleau formation in the fresh blood preparation, if the blood spreads easily between slide and coverglass, if there is little granular matter between the red cells, if fibrin threads do not appear within 8 minutes, if the monocyte count is under 4 per cent and the lymphocyte count over 30 per cent, if the neutrophile nuclei show a smooth or regular contour, if the neutrophile count is over 80 per cent, and if there are no abnormal monocytes. In favor of cancer are viscid blood, absence of rouleaux, tight cohesion of red cells, early appearance of a dense fibrin network with abundance of granular matter in the meshes and actively moving leucocytes at room temperature, and tendency of the red cells in the centers of the "islands" or bands to undergo hemolysis, being converted into a homogeneous material. Other signs are reduction in microlymphocytes, irregular nuclear contours of the neutrophiles often associated with thick nuclei, polymorphous and very large platelets, abnormality in the contour of the nucleus in the monocytes, and the occurrence of mitochondrial inclusions in the mononuclear leucocytes. All gradations exist between a definite cancer reaction and a definitely noncancerous blood. Vivid illustrations are given of the diagnostic criteria and tables summarize the author's results.

These studies open up a new approach to the study of the blood in cancer. More work must be done before these special tests are established as aids in the diagnosis of malignant disease.

HOWARD L. ALT.

THE experience of one of the leading radiologists of England, who is well known for his book *Radiologic Atlas of Chronic Arthritis* (*The Hand*), is presented in *Adolescent Spondylitis or Ankylosing Spondylitis* by S. Gilbert Scott.[2] Scott describes a type of patient who if taken in time can be saved but if neglected either through misdiagnosis, ignorance, or delay will become what he calls a "spondylitic wreck," which is illustrated in the frontispiece.

The primary object of all medical research must be the prevention rather than the cure of disease. If prevention is not possible the next best thing is early diagnosis and complete arrest of the pathological process. The clinical diagnosis of spondylitis can be made 5 years before the onset of spinal symptoms which can be completely arrested by the use of wide field roentgen therapy during the prespondylitic stage.

Spondylitis deformans includes any type of spondylitis that leads eventually to deformity. There is the spondylitis that attacks the young adult—known as ankylosing spondylitis, or, preferably, adolescent spondylitis—and the spinal arthritis of the elderly or aged patient—known as spondylitis osteoarthritica, or old man's spondylitis.

Scott suggests the term adolescent spondylitis for ankylosing spondylitis that attacks the young adult. The onset is insidious, extending over a period of 5 to 7 years before the appearance of spinal symptoms. It attacks the young, healthy athlete, usually the male. Infective changes are always present in the sacroiliac joints. During the active stages of this joint infection no pain is felt either over the sacroiliac joints or in the back. Bony ankylosis of the sacroiliac joints is nearly always complete by the time the clinical signs of spondylitis appear. The sacroiliac joints always present pathological changes.

If this disease is to be eradicated, radiologists must assist by making themselves familiar with the early changes in the sacroiliac joints associated with the prespondylitic phase. All physicians must be able to recognize the characteristic clinical history. The condition always begins in early adult life in spite of the fact that symptoms may sometimes be delayed until late middle age. Attacks of rheumatic pains referred not to the back or sacroiliac joints, but to various parts of the body, occurring in a young adult, over a period of years, should suggest a radiologic scrutiny of the sacroiliac joints. The so called adolescent kyphosis is not a pathological entity but an excessive kyphosis associated with the final stages of adolescent spondylitis.

[1] A STUDY OF THE BLOOD IN CANCER; WITH SPECIAL REFERENCE TO THE NEEDS OF THE TUMOUR CLINIC. By O. Cameron Gruner, M.D. (Lond.). Montreal: Renouf Publishing Co., 1942.

[2] A MONOGRAPH ON ADOLESCENT SPONDYLITIS OR ANKYLOSING SPONDYLITIS; THE EARLY DIAGNOSIS AND ITS TREATMENT BY WIDE-FIELD X-RAY IRRADIATION. By S. Gilbert Scott, M.R.C.S., L.R.C.P., F.F.R., D.M.R.E. (Camb.). Published under the auspices of the Nuffield Wide-Field X-ray Therapy Research, Research No. 1. London: Humphrey Milford (Oxford University Press), 1942.

The onset of infection in the sacroiliac joints does not coincide with the onset of spinal symptoms of spondylitis. The painful and stiff spine, so characteristic of spondylitis described in textbooks, represents the last and not the first chapter of the disease. Over 90 per cent of the patients Scott examined had been good swimmers. The majority would say: "I have had growing pains and attacks of wandering rheumatic pains ever since I was a boy." The only clinical sign present may be pain in the hip or ankle, or in any part except the back or the sacral region. Attacks of rheumatism in a growing youngster may be of more serious import than the symptoms might suggest.

The fundamental fact remains that changes of some sort can actually be detected by means of a radiographic examination several years before there is any clinical suspicion that the patient may eventually develop spondylitic symptoms. Scott finds the stereoscopic films are of no advantage and that the most reliable information is obtained from roentgenograms taken in the routine standard projections.

The author describes the advances in obtaining a complete radiographic record of sacroileitis. He is responsible for the treatment of sacroileitis which Americans call sacroiliac disease or sacroiliac arthritis. He describes the normal sacroiliac joint and illustrates it with gross anatomic specimens and roentgenograms. He describes prespondylitic symptoms and recurrent attacks of rheumatism in the young adult as wandering pains and growing pains. These patients sometimes have abdominal symptoms resembling girdle pains which have led to the erroneous diagnosis of gastric ulcer or gall-bladder disease. One unfortunate characteristic of these prespondylitic cases is that they have a definite tendency to be intermittent and may entirely disappear for a time with or without treatment. This temporary remission gives both the doctor and the patient a false sense of security.

Scott recommends wide field radiotherapy when other orthodox measures fail. The immediate results have so far been satisfactory.

There is a short chapter on the interpretation of the roentgenograms of the sacroiliac joints in the 1st, 2nd, and 3rd phases of the disease. The differential diagnosis includes tuberculous sacroileitis, tuberculous hip, tuberculous disease of the hip joint, sacroileitis associated with spondylitis, hip symptoms associated with spondylitis. He summarizes the signs of activity of the disease. There is an interesting chapter on calcification of the spinal ligaments and another on decalcification of vertebral and pelvic bones. Bacteriological research is described.

The remarkable results Scott so far has obtained with wide field roentgen-ray therapy in 300 cases of spondylitis in all stages extending over a period of 8 years justifies his conclusions that complete and permanent arrest of this disease is possible in a large majority of, if not in all, cases provided they are treated during the prespondylitic period.

PHILIP LEWIN.

THE first edition of *Essentials of Pathology*[1] by Lawrence W. Smith and Edwin S. Gault was published in 1938, and the volume now reappears in its second revised edition.

The first thirteen chapters on general pathology, which, in the first edition, were disproportionately brief for a textbook, have been completely rewritten and expanded. The authors have utilized the prevailing opinions and left out controversial material whenever possible in an attempt to provide the student with a clear picture of the fundamental principles of pathology. When necessary, conflicting theories are briefly but adequately explained to relieve what would otherwise be an overly dogmatic viewpoint.

A well selected bibliography has been added to this edition, which, according to the authors, includes three types of references: documents of historical importance; recent monographs and reviews in which complete bibliographies of any particular subject may be found; and current papers of interest. The bibliography comprises sixteen pages at the end of the book and is indexed by chapter heads in Roman numerals, making ready reference somewhat difficult; however, it is a very valuable addition and greatly extends the scope of the book beyond the "essentials" for those who desire more detailed information on a given subject.

Two hundred and ninety-five brief case histories with autopsy findings are correlated with the textual material and the book is adequately illustrated with six hundred and seventy-nine uniformly excellent figures of gross and microscopic pathology, some of which are in colors and many of which are taken from cases discussed in the text.

The book is highly recommended, because of its practical clinical approach, both to the student of pathology and to the practitioner who desires a brief, readable, well illustrated reference book for a review of pathology.

D. O. MANSHARDT.

IT is stated by General J. C. Magee that, "The great burden of medical care in this war will fall on medical officers outside the highly specialized fields. It is thus essential that nearly all medical officers be familiar with principles of military surgery." To place in the hands of the medical officers in the field the most modern and concise information possible, the National Research Council is publishing a six volume series, each volume dealing with a different specialty as it is related to war surgery. The first volume of this series is entitled, *Manual of Standard Practice of Plastic and Maxillofacial Surgery*.[2] Its editorial board is made up of men outstanding in the field of reconstructive surgery.

[1] ESSENTIALS OF PATHOLOGY. By Lawrence W. Smith, M.D., and Edwin S. Gault, M.D., with a foreword by James Ewing, M.D. 2d ed. New York and London: D. Appleton-Century Co., Inc., 1942.

[2] MANUAL OF STANDARD PRACTICE OF PLASTIC AND MAXILLOFACIAL SURGERY. Prepared and edited by the Subcommittee on Plastic and Maxillofacial Surgery of the Committee on Surgery of the Division of Medical Sciences of the National Research Council and Representatives of the Medical Department, U.S. Army. Philadelphia and London: W. B. Saunders Co., 1942.

As stated in the title, this book is a manual. In it are found condensed statements dealing bluntly with established procedures as well as with some debatable practices. For example, the chapter on skin grafting opens with: "Do not use isografts (another person) or zoografts (another species)." "Reverdin (pinch) Grafts: These grafts have no place in the surgery of the face and neck. In fact they no longer have any proper place in modern surgery." And so a subject, discussed at length by most authors, is disposed of in a few words. Rightfully dogmatic statements are also made when it is stated, "Do not use homologous or heterogenous bone," but, "both autogenous (same person) and homologous (same species) cartilage is usable." As directed by this manual then, only autografts are usable, the one exception being homografts of cartilage. It is unfortunate for many that such rules were not promulgated long ago.

First aid and emergency treatment is stressed throughout the text with due consideration being given to the question of shock in all cases. Many ingenious methods of fixing, bandaging, and transporting injured persons are described and particular emphasis is placed upon utilization of materials at hand, an important consideration when dealing with war time injuries.

The book has no bibliography but proper credit is given for the many excellent illustrations. As in all compilations of this nature, an adequate index is supplied to aid in answering specific points in a hurry. This manual tells how and when the most effective procedures should be carried out, making a point to avoid consideration of debatable issues. It is written to fulfill the demands of medical men engaged in total war. WAYNE B. SLAUGHTER.

THE authors of *Diseases and Injuries of the Larynx*,[1] Dr. Chevalier Jackson and his son, Dr. Chevalier L. Jackson, need no introduction to the medical profession.

This remarkable book is a new edition describing definite clinical aspects and facts of all known laryngeal diseases. Each one is carefully considered as to the definition, incidence, etiology, pathology, symptoms, diagnosis, treatment, and prognosis.

In discussing the treatment of the various laryngeal disorders great care is taken in pointing out the things which should not be done as well as those to be done. The authors recommend that all obstetricians and their assistants should learn to pass an infant size bronchoscope and thus save the life of many a newborn.

The several hundred illustrations consist of pen, pencil, wash drawings, color plates, and halftones drawn from life by the authors. Such illustrations add greatly to the teaching value of this text.

The authors in bringing this book to a close have added a new chapter on war injuries to the larynx. The cause and treatment of these traumatic lesions are described in detail.

The thoroughness and precision with which this book is written make it an indispensable text for the laryngologist, the general practitioner, the surgeon, and the student. LINN F. MCBRIDE.

[1] DISEASES AND INJURIES OF THE LARYNX; A TEXTBOOK FOR STUDENTS AND PRACTITIONERS. By Chevalier Jackson, M.D., Sc.D., LL.D., F.A.C.S., and Chevalier L. Jackson, A.B., M.D., M.Sc. (Med.), F.A.C.S. New York: The Macmillan Co., 1942.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

SYNOPSIS OF TRAUMATIC INJURIES OF THE FACE AND JAWS. By Douglas B. Parker, M.D., D.D.S. St. Louis: C. V. Mosby Co., 1942.

FRACTURES. By Paul B. Magnuson, M.D., F.A.C.S. 4th ed. Philadelphia, Montreal, and London: J. B. Lippincott Co., 1942.

REFERRED PAIN: A NEW HYPOTHESIS. By G. W. Theobald, M.D. (Cantab.), M.R.C.P. (Lond.), F.R.C.S. (Edin.). Colombo, Ceylon: Times of Ceylon Co., Ltd., 1941.

THE HOSPITAL CARE OF THE SURGICAL PATIENT; A SURGEON'S HANDBOOK. By George Crile, Jr., M.D., and Franklin L. Shively, Jr., M.D., with a foreword by Evarts A. Graham, M.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1943.

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BIOCHEMISTRY AND MORPHOGENESIS. By Joseph Needham, F.R.S. New York: The MacMillan Co., 1942.

RECENT ADVANCES IN ANAESTHESIA AND ANALGESIA (INCLUDING OXYGEN THERAPY). By C. Langton Hewer, M.B., B.S. (Lond.), D.A. (R.C.P. & S. Eng.). 4th ed. Philadelphia: P. Blakiston's Son & Co., 1943.

AMPUTATIONS AND ARTIFICIAL LIMBS. By R. D. Langdale-Kelham, M.R.C.S., L.R.C.P., and George Perkins, M.C., F.R.C.S. General Editor, The Rt. Hon. Lord Horder, G.C.V.O. London: Humphrey Milford (Oxford University Press), 1942.

THE TREATMENT OF SHOCK. By R. W. Raven (Major, R.A.M.C.), F.R.C.S. General Editor, The Rt. Hon. Lord Horder, G.C.V.O. London: Humphrey Milford (Oxford University Press), 1942.

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THE SEXUAL GLANDS OF THE MALE. By Oswald Swinney Lowsley, A.B., M.D., F.A.C.S. Collaborators: Frank Hinman, A.B., M.D., F.A.C.S., and Donald R. Smith, A.B., M.D., F.A.C.S. (Reprinted from Oxford Loose-Leaf Urology). New York, London, Toronto: Oxford University Press, 1942.